Public procurement for innovation: firm-level evidence from Italy and Norway

Public Procurement for Innovation: Firm level evidence from Italy and Norway

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Abstract

Controlling for factors affecting the participation in the procurement market, this paper attempts to identify the main determinants of firms' propensity to undertake innovative activities as part of public procurement contracts. The empirical analysis is carried out by using micro-data from two Community Innovation Surveys for Italian and Norwegian firms. We find that small and medium-sized firms, as opposed to larger companies, have a lower capability to enter into the procurement market; however, once they succeed, they are equally capable of offering innovative solutions to public buyers. Another major result regards firms' cooperation with universities and public research institutes, which seems to play a key role in order to facilitate firms' involvement in public procurement for innovation. Although there are some differences in the estimated coefficients of explanatory variables, these results are consistent between Italy and Norway.

JEL codes: O31, O33, O38, H57

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1. Introduction

Public procurement (or PP henceforth) is the purchase of goods and services by governments and state-owned companies. Starting from the early 2000s, the European Union (EU) and the European Commission (EC) have stressed the need and pushed Member States to use PP as a demand-side policy instrument to foster innovation. The Directive 2004/18/EC established that the contracting authorities could include special conditions related to the performance of a PP contract: along with the lowest price, the inclusion of other award criteria such as quality, technical merit and functional characteristics was allowed. Subsequently, the Communication of the EC (2007) opened the door to the use of Pre-commercial Procurement for the acquisition of R&D services. Then, the Europe 2020 agenda included among the commitments of the Innovation Union the following: "From 2011, Member States and regions should set aside dedicated budgets for pre-commercial procurements and public procurements of innovative products and services" (cf. EC, 2010; p. 17). This process culminated in 2014, when the EU adopted two revised Directives on public procurement, (2014/24/EU and 2014/25/EU) providing a specific legal framework to promote the procurement of innovations. Instead of rigid tender specifications, the new directives favour functional specifications that allow suppliers to come up with innovative ways of solving a problem or meeting public needs. Furthermore, procurers are encouraged to use life-cycle cost considerations (in which innovative products are proved to be superior), rather than applying, as award criterion, the lowest price only.

In the EU, a growing attention has also been paid to promote the involvement of Small and Medium-sized Enterprises (or SMEs henceforth) in the public sector marketplace. Indeed, given the centrality of SMEs to employment creation, entrepreneurship and industrial renewal, the concern for their under-representation in the PP market has increased the adoption and diffusion of SME-friendly procurement provisions. In this regard, for instance, besides the guide on public procurement as a driver of innovation in SMEs (EC, 2014), we can recall some specific provisions included in the above mentioned 2014 EU directives, such as the open encouragement to dividing large size procurement contracts into lots.

The mounting interest in the use of PP as an innovation policy tool is mainly due to the fact that supply-side innovation policies (R&D public subsidies and tax incentives) are deemed to be insufficient to meet the current challenges in promoting competitiveness, also because of increasing budgetary constraints. Nonetheless, "there is very limited statistical evidence on the link between public procurement and innovation" (cf. Appelt and Galindo-Rueda. 2016, p. 6). Still in the early 2000s, the empirical literature on public procurement for innovation was rather fragmented and mostly limited to case studies (e.g. Edquist et al., 2000; Edler et al., 2005). Only recently, papers

based on sound statistical and/or econometric evidence have been published: see, among others, Guerzoni and Raiteri (2014), Uyarra et al. (2014), Slavtchev and Wiederhold (2016), Flynn and Davis (2017), Saastamoinen et al. (2018), Czarnitzki et al. (2018), Florio et al. (2018), Crespi and Guarascio (2019).

To contribute to this relatively under-researched topic, in this paper we carry out a micro-econometric analysis with the aim of identifying the main determinants of firms' participation in Public Procurement for Innovation (or PPI henceforth). Therefore, the main original aspect of this paper is that of analysing the relation between public procurement and innovation from a new perspective. Indeed, our focus is on the factors affecting the likelihood of firms' involvement in PPI, particularly by comparing this latter to Regular Public Procurement (or RPP henceforth), rather than on examining the contribution of public procurement to firms' success in terms of increased innovation inputs or outputs. This has been the object of the available empirical studies (see above), whilst less attention has been paid to the question of what firms' characteristics or strategies increase the probability that firms undertake innovative activities as part of PP contracts.

In order to address this issue, we put forward some research hypotheses about the role of firm size and cooperative alliances with different external actors. As for the former, while there is extensive evidence that SMEs are "disadvantaged" in accessing the PP market in that they face several barriers (internal or external) that prevent them to participate and be awarded in public tenders (e.g. Uyarra et al., 2014), there are only few studies on the factors enabling their participation in PP (e.g. Flynn and Davis, 2017; Saastamoinen et al., 2018). Most importantly for the scope of this study, to our knowledge, no previous research has focused on SMEs' involvement in PPI as opposed to RPP activities.

Regarding firms' external collaborations, we contend that they could play a crucial role for two main reasons. First of all, they could be a source of valuable information about market opportunities as well as of knowledge for innovation, which then might improve firms' capacity to offer innovative solutions to public administration providers. Second, they could be precious to help firms in overcoming the difficulties that, due to a lack of internal resources and capabilities, often impede them to participate in large public tenders. Therefore, especially in the case of SMEs, external cooperative relationships could compensate for size-related disadvantages and increase the probability that such firms will take part in PPI.

Obviously, we also control for other relevant factors, such as the human capital endowment and the type of innovative activities carried out, that might increase firms' propensity to undertake innovative activities related to PP contracts.

We conduct this study by using micro-data from two Community Innovation Surveys carried out in Italy and Norway, which have released information on firms having public procurement contracts. This allows us to examine whether some potential determinants of PPI at the firm level are the same in two very different institutional and economic contexts. This represents a further contribution of this paper because, to our knowledge, there are no studies on this topic comparing results across countries.

With respect to the econometric strategy, we estimate the probability of being engaged in PP and, particularly, in PPI by considering all the firms included in the available CIS samples for Italy and Norway. In this way, we analyse and compare the factors affecting firms' access into PP market with those that specifically determine the participation in PPI. Indeed, firms involved in PPI are also confronted with all other firms, regardless of whether these latter have been able to enter into the PP market and, thus, obtain a PP contract. Next, we perform probit regressions for PPI by restricting the samples to firms engaged in PP, which allows us to examine the firms' characteristics or strategies that facilitate their engagement in PPI conditional on their participation in PP and, thus, compared to those firms that only obtain RPP contracts. However, since in this case the dependent variable is observable only for firms that have been able to enter into the PP market (i.e. to obtain a PP contract), to avoid the risk of a selection bias, we also carry out a robustness check based on a Heckman sample selection model. This allows us to model firms' decision to take part in PPI as made of two interrelated and subsequent choices and, therefore, to find the main determinants of firms' propensity to undertake innovative activities related to PP, controlling for factors affecting their participation in the PP market.

The paper is organised as follows. In Section 2 we outline the key concepts and definitions, discuss the backgrounds of the study and define the main research hypotheses to be tested; also, we provide insights about the institutional and legal frameworks concerning PPI in Italy and Norway. Section 3, after describing the data and presenting some descriptive statistics for the Italian and Norwegian firms involved in PP and PPI, illustrates the econometric approach and the explanatory variables used in subsequent empirical analysis. Section 4 compares the results achieved for Italian and Norwegian firms. Section 5 contains some concluding remarks and policy considerations.

2. Public procurement for innovation

2.1 Key concepts and definitions

According to Edquist and Zabala-Iturriagagoitia (2012, p. 1758) "Public Procurement for Innovation (PPI) occurs when a public agency places an order for the fulfilment of certain functions

within a reasonable period of time (through a new product)". As such, this is usually opposed to Regular Public Procurement (RPP), which takes place when a public body buys goods and services that already exist (i.e. where no innovation is involved). Obwegeser and Müller (2018, p.5), have also stressed that the concept of "public procurement for innovation" is different from that of "innovative public procurement": indeed, the former addresses the issue of "How can public procurement drive innovation?" while the latter refers to the question of "How can public institutions procure innovatively?"

The European Commission distinguishes between "Pre-commercial Procurement" and "Public Procurement of Innovative Solutions". In the first case, public buyers purchase R&D services that are likely to give rise to entirely new goods or services (EC, 2007). However, as Edquist and Zabala-Iturriagagoitia (2015) clarify, this represents a form of research contract that does not necessarily involve actual product development or the purchase of new products; therefore, it cannot be considered as PPI and, rather, should be characterised as a supply-side innovation policy measure. In the second definition, instead, "the contracting authorities act as launch customer for innovative goods and services that are not yet available on a large-scale commercial basis" (EC, 2014, p. 12). This is particularly important for SMEs: by providing stable and predictable sources of demand, such PP contracts allow them to make plans for the future, i.e. expand investments in new technologies, capital equipment and human resources (Flyinn and Davis, 2017).

Furthermore, some authors (see e.g. Edquist and Zabala-Iturriagagoitia, 2012 and Edquist e al., 2015) propose a distinction between two main types of PPI, depending on the degree of innovativeness of the innovation process: developmental/radical or adaptive/incremental PPI. The first type implies the creation of entirely new products or systems, while the second involves innovations based on the recombination of existing goods and services, thus necessary to adapt an existing product/system to specific national or local conditions.

In the present paper, we refer to such a broad definition of PPI. Indeed, in our perspective, PPI does not necessarily refer to entirely new products, but also entail the development of existing products and production processes into new areas or application; therefore, it does not only trigger but also respond to innovation by "favouring goods or services, which have innovative characteristics" (Georghiou et al., 2014, p. 2).

As recently stressed by Uyarra et al. (2017; p. 4) "adopting a broad definition is vital, since […] much procurement related innovation at the local and regional level is incremental and of a responsive nature rather than radical". The micro-econometric analysis carried out by Czarnitzki et al. (2018) supports the above statement by showing that the involvement in PPI contracts increases

the turnover of German firms derived from product and services not radically new (i.e. new to the firms but not to the market).

2.2. Background literature and hypotheses development

From a theoretical point of view, the discussion on PPI is intrinsically linked to the debate on the role of demand as a driver of innovation. Scholars embracing the demand-pull approach have always emphasized the importance of demand dynamics as a crucial factor influencing both the decision of firms to innovate and the direction of innovative efforts. The intuition regarding the role of demand for innovation has been sparked by the seminal contribution of Schmookler (1966), who claimed that demand conditions crucially influence the desirability and realization of innovations: indeed, the existence of an expected profitability through market expansion represents the key stimulus to which innovative firms actually react. However, since the 1980's, the focus of the literature has shifted in favour of supply-side factors. Only more recently, starting from the work by Edler and Georghiou (2007), the long debate between the supply-push versus demand-pull sources of innovation has settled for a more balanced view, which sees demand as a complementary factor driving innovation. Among the most recent contributions, Slavtchev and Wiederhold (2016) find that government demand has stimulated private R&D expenditures across US States, while Crespi and Guarascio (2019) show that public demand has been an effective mean to foster patenting activities among the industries of 24 OECD countries.

In this paper, we provide a new perspective on the relation between public procurement and innovation by focusing on the factors affecting the likelihood of firms' involvement in PPI, not only in general, that is, compared to all other firms (i.e. irrespective of whether these latter have been able to enter into the PP market), but also compared to other firms involved in PP (i.e. those that only obtain RPP contracts). So far, the existing empirical studies have examined the contribution of public procurement to firms' success in terms of increased innovation inputs and outputs (e.g. Aschhoff and Sofka, 2009; Guerzoni and Raiteri, 2014; Czarnitzki et al., 2018) or economic performances (e.g. Florio et al., 2018), whilst less attention has been paid to the factors increasing the probability that firms carry out innovative activities induced by PP contracts.

A crucial issue, stressed by scholars and policy makers, is the uneven presence in the PP market of firms with different size. In this regard, there is extensive evidence that SMEs are "disadvantaged" in that they do not achieve a percentage of public procurement contracts proportionate to their economic importance (GHK, 2010; Flynn et al., 2015; OECD, 2018). Barriers faced by SMEs to participate and be awarded in PP can be both internal and external to the firms (Obwegeser and Müller, 2018). The former are mainly due to the lack of information and knowledge about the

opportunities offered by PP and the procurement process itself (Nicholas and Fruhumann, 2014). Along with insufficient information, SMEs generally suffer from inadequate levels of legal expertise and administrative capacity that are necessary for tendering. Moreover, Flynn and Davis (2017) contend that, along with these procedural capabilities (related to technical and formal aspects of tendering and subsequent contract administration), also relational capabilities (the ability to influence and communicate with public buyers) are of mounting importance for winning PP contracts. On the other hand, the obstacles external to the firms (i.e. inherent to the PP process) are mainly due to the presence of high administrative costs, large and long-lasting contracts and onerous qualification criteria (e.g. guarantees of financial strength). Moreover, the risk aversion of public agencies might result into selection criteria that privilege firms with larger size and a longer experience as public administrations' providers (Uyarra et al., 2014). Hence, due to presence of rules that favour incumbent firms, even innovative and dynamic SMEs, able to provide new solutions to public buyers, could find it difficult to win a PP contract.

In principle, in comparison with the procurement of already existing goods and services for the lowest possible price, PPI should require a higher degree of competence both within public administrations and firms. As for the firms, obtaining a PPI contract would require a certain degree of organisational and R&D-related work to fulfil the demand of the public buyer and therefore the capacity to mobilise all their internal resources not only to go through the procedural hurdles of public sector tendering, but also (and most importantly) to reach the goal of formulating a value proposition that satisfies the expectations of the purchasing organisation (Flynn and Davis, 2017). Since the firm size is generally associated with greater human capital endowment and financial resources as well as the presence of in-house R&D activities, the firms dealing with PP for innovation should be larger than the others (included those with only regular PP contracts).

However, although the firm size exerts a strong impact on the involvement in PP (see above), the fact that smaller businesses have less potential to deliver innovative solutions to public buyers cannot be taken for granted. In our view, for a rigorous assessment of the factors facilitating firms' involvement in PPI, it is important to take into account the possible barriers that smaller businesses have to face in order to enter into the PP market, irrespective of whether the procurement contracts entail innovation or not.

The above arguments lead us to test, separately, the following hypotheses:

Hypothesis 1a: larger firms are more likely to be involved in PP contracts (either regular or for innovation);

Hypothesis 1b: larger firms are more likely to be involved in PP contracts for innovation.

Having stressed the crucial role of firm size, a factor that could compensate for size-related

disadvantages is the firms' cooperation with different external actors: these latter can be important sources of information and knowledge as well as partners for strategic alliances to capture new market opportunities. Indeed, external actors might substantially contribute to increase the general information and awareness of firms about the availability and potential advantages of PP and, especially, PP for innovation. Moreover, firms with wider access to multiple sources of external knowledge through cooperation should be in a better position to offer innovative solutions to public buyers. Which type of external partners could be more effective in this regard is a matter of empirical evidence. Robin and Schubert (2013) find that, for German and French firms, the introduction of new goods and services is fostered by the cooperation with public research institutions, while that with other private organisations do not play a significant role. Instead, looking at Finnish SMEs, Saastamoinen et al. (2018) show that the involvement in PP for innovation is positively affected by the participation in networks with other firms. However, while the former authors consider external partners as knowledge sources, the latter contend that effective cooperation with other firms is particularly important for SMEs also because such partnerships help them to overcome their inherent disadvantages in terms of resources and capabilities (see above) that impede their participation in large public tenders.

Moving from these considerations, we introduce the following hypothesis:

Hypothesis 2: firms that cooperate with different external actors have a greater probability to be involved in PP for innovation.

Obviously, for a rigorous test of the above main hypotheses of our study it is necessary to control for other possible determinants of firms' involvement in PP and, especially, in PPI. Among them, the endowment of human capital, captured by the educational level of employees, should be taken as a proxy of the procedural and relational capabilities of the firms (see above) that are likely to increase the participation in PP markets. Moreover, the involvement in innovative activities mainly devoted to the introduction of new goods and services (rather than new production processes) should significantly increase the firms' chances to take part in PP for innovation (Reijonen et al., 2016). On this regard, Uyarra et al. (2014), among others, have stressed that the lack of public sector demand for innovation is a strong barrier for suppliers with high commitment to R&D activities and product innovation. Therefore, we expect that firms with PPI contracts are more likely to be engaged in innovative activities aimed at new product development, such as R&D, product design and marketing innovations.

2.3 Policy frameworks related to PP for innovation in Italy and Norway

This paper is mainly based on a micro-econometric analysis carried out in two very different institutional and economic contexts. In the next section we shall make clear that the choice of Italy and Norway is mainly due to the availability and quality of homogenous micro-data, which refer to the period 2010-2012 for Italy and to 2012-2014 for Norway. Thus, in both cases, the firms' involvement in PP and PPI precedes the 2014 EU Directives on public procurement. Nonetheless, this should not represent a severe limitation of our study because the diffusion of PP for innovation, although slowly and unevenly among European countries, started well before 2014, also thanks to the stimuli coming from the same European institutions during the 2000s (see the introductory section). For instance, according to Aschhoff and Sofka (2009), whose empirical study will be described in the next section, between 2000 and 2002 about 5% of the German innovative firms took significant advantage from public procurement in their innovation activity.

This section illustrates some policy initiatives and provides additional information suggesting that also in Italy and, especially, in Norway, the use of PP for innovation preceded the 2014 EU Directives.

As for Italy, it should be stressed that since the late 1990s the Italian government has undertaken some (direct and indirect) actions to support SMEs' participation in public tenders. Greater policy efforts have been devoted to the rationalization of regular PP activities and for making the PP market more open to competition. These goals were achieved through the institution, in 1998, of Consip S.p.A., a public limited company entrusted to act as the central purchasing agency on behalf of the Italian Government and the launch, in 2004, of the MePA (Electronic Marketplace for the Public Administration), which has provided a remarkable impulse to SMEs' participation in the market for low-value public contracts (i.e. below the EU threshold). Less attention, instead, has been paid to specific policies concerned with PP for innovation. Therefore, for a long time, the implementation of innovation-oriented procurement projects has been left in the hands of individual (mainly regional) actors, that is, without any legal or institutional framework. Starting in 2012, the Italian government has defined a programme for the pre-commercial procurement of R&D and innovation in services. However, aside from this programme and the transposition of the 2014 European directives, there is not yet a comprehensive national strategy for boosting the use of PPI (cf. OECD, 2017a). Despite these legislative and institutional limitations, a recent report from the National Research Council (CNR, 2019) documents that in Italy, already between 2009 and 2012, there were 230 public contract notices classified as procurement for R&D services in the Tender's Electronic Daily database of the EU. Interestingly, about 28% of these contracts were held by regional governments. It deserves to be stressed that the above figure underestimates the PPI

diffusion in Italy since the TED database only records the tenders above established thresholds and, most importantly, does not allow to highlight those that require to perform innovative activities but are not identified as R&D procurements. On the other hand, a small fraction of the latter could be classified as PCP (Pre-Commercial Procurement) contracts[1]. Accordingly, the "contract notices for R&D services" do not fully correspond to the broad definition of PPI adopted in the present study (see Section 2.1).

Moving to Norway, although the country is not a member of the EU, its legislation on public procurement is currently based on the EU 2014 directives, in accordance with Norway's obligations under the European Economic Area (EEA) Agreement. However, even well before the recent revision of the legal framework, Norway has garnered a long experience in supporting PP for innovation by undertaking numerous measures that, over time, have given rise to a coherent strategy. For instance, since 1968 the Norwegian government has funded Industrial and Public R&D Contracts (IFU/OFU), in which suppliers cooperate with public sector buyers in developing new products or services. Among the subsequent initiatives preceding the year 2014, we can recall the strategic programme "Industrial and Public Research and Development Contracts", launched in 2004 by Innovation Norway (a state-owned company and innovation development bank), aimed at stimulating user-driven innovation based on binding agreements between public bodies and innovative Norwegian firms: each year about 60 projects have been funded by the programme (OECD, 2017a). Moreover, since 2010 the National Programme for Supplier Development supports innovation and creativity within public procurement "through concrete procurement for innovation projects, method development and capacity building activities" (ibid., p. 138). To our knowledge, the Norwegian government has not adopted specific policy measures to increase small businesses' participation in public tenders.

3. Empirical analysis

3.1 Data and dependent variables

The Community Innovation Survey (CIS) provides cross-sectional data on a wide array of aspects related to firms' innovative activities and performance collected by means of a postal questionnaire developed by the European Commission (Eurostat) and Member States, under the guiding principles of the Oslo Innovation Manual (OECD, 2005). The survey is carried out every four years and collects data for very large samples of firms, representative of all manufacturing and services industries across Europe. As for Italy, the Italian National Institute of Statistics (ISTAT) has

[1] We contend that this could have occurred for a "small fraction" of the 230 cases of procurements for R&D services because in Italy the diffusion of PCP contracts has been very limited (cf. CNR, 2019).

provided the CIS 2012 dataset concerned with the years 2010-2012. With respect to Norway, the micro-data, provided by Eurostat, are taken from CIS 2014, which refers to 2012-2014. It should be stressed that CIS data are based on self-reported and subjective assessments. However, following the Eurostat guidelines, national statistical offices adopt various devices and techniques to increase the reliability of the survey (for instance, by including detailed definitions and examples in the questionnaire and by checking for non-responses and multiple-choice answers).

Drawing on the firms' answers to the CIS questionnaires under consideration, we have been able to construct the two key dependent variables of our analysis. The first one, *Public Procurement*, is a binary indicator equal to 1 if a firm has declared to have any PP contract (i.e. without specifying whether involving innovation or not)[2]. Then, we have built a second dummy variable, *Public Procurement for Innovation*, for firms declaring to carry out innovative activities as part of PP contracts[3].

As far as our knowledge is concerned, Aschhoff and Sofka (2009) is the first study in which a variable for public procurement involving innovation activities has been derived from a CIS, which in Germany corresponds to the "Mannheim Innovation Panel" (MIP) survey. These authors have used the 2003 survey, concerned with the years 2000-2002, in order to find a dummy variable for innovative firms that were stimulated by public procurement. This variable was derived from the answers to the following question: "Have you introduced significantly improved products or processes between 2000 and 2002 because specific customers asked for them or demanded them directly? If yes, from which industry did they come?". Aschhoff and Sofka considered "public procurement as an important source of innovation for a firm if the respondents indicate that the customers came from public administration, defence or compulsory social security variable" (ibid, p. 1239). By doing so, they found that the firms involved in public procurement for innovation accounted for only 5% of total innovative firms. However, despite such a low percentage, their PPI dummy was quite effective in explaining the share of firms' turnover due to new products.

More recently, Czarnitzki et al. (2018) have employed the 2013 wave of the same survey to assess the link between public procurement and innovation in Germany. As in our case, and unlike that used by Aschhoff and Sofka, the questionnaire contains two specific and direct questions concerned with both PP and PPI (cf. footnotes 2 and 3). Consequently, Czarnitzki et al. have been able to distinguish between PP for innovation and regular PP contracts. Their results show a positive and

[2] Within the section on public procurement of the CIS 2012 and 2014, the first question reads "During the three years 2010 to 2012 (or 2012 to 2014) did your enterprise have any procurement contracts to provide goods or services for domestic or foreign public sector organisations?"

[3] The second, subsequent, question reads: "Did your enterprise undertake any innovation activities as part of a procurement contract to provide goods or services to a public sector organisation?"

statistically significant impact of PPI on firms' turnover from new products and services, while RPP does not exert a significant effect.

Thus, by using the CIS 2012 and 2014 data at our disposal for Italy and Norway respectively, we employ the same direct indicators of PP and PPI (see above). It must be stressed that, according to the information provided by the CIS, PPI may occur even when innovation is not explicitly required by the public contract and regardless of whether the innovative activities carried out by the firms have led to the successful introduction of innovations.

The comparison between Italy and Norway is mainly due to data availability and quality. Indeed, for stressing the role of different institutional features, we wanted to compare a southern European country with a Northern one. For the latter we could also refer to Germany or Finland. Nevertheless, in both countries the CIS survey does not include firms in the construction sector which, instead, are widely covered in both the Italian and Norwegian datasets and turn out to be highly engaged in PP contracts (see the next sub-section). With respect to Southern European countries, CIS data at the firm level were also available for Portugal. However, data on this country show not only a very low share of firms participating in PP (and especially in PPI), but also a very low presence of firms in the construction sector.

3.2. Descriptive statistics on firms involved in PPI

By using the micro-data at our disposal, in this section we provide a broader characterisation of the Italian and Norwegian firms engaged in PP and carrying out innovation as part of PP contracts.

Appelt and Galindo-Rueda (2016) report that between 9% and 34% of firms operating in countries for which data are available (most of them coming from CIS 2012) have delivered goods or services to public authorities. Table 1 thus shows that the two countries under exam are among the top European performers, even though Norwegian firms participate in PP more frequently (34%) than firms in Italy (27.5%). Looking at the firms involved in PPI, the share in Norway (8.6%) is almost twice than that recorded in Italy (4.5%). Such a big difference could be due, among other things, to the fact that in Norway, as opposed to Italy, the policy goal of inducing innovations via PP contracts has been prioritised by the government and pursued with greater determination and effectiveness (cf. Section 2).

Table 1. Firms involved in PP and PPI: absolute value and percentages on total firms

	Italy (CIS 2012)	Norway (CIS 2014)
Total number of firms	18697	4974
Firms with Public Procurement	5137 (27.47)	1691 (34.00)
Firms with Public Procurement for Innovation	834 (4.46)	426 (8.57)

Source: own computations on CIS 2012 Italian and CIS 2014 Norwegian data.

Hence, according to Table 1, most of the firms with PP contracts have not undertaken innovative activities in connection with such contracts. This does not exclude that such firms have been engaged in some kind of innovative activities in an autonomous way: in fact, 43% of the Italian firms with regular PP contracts can also be classified as innovative since they have introduced new products or processes during the reference period (2010-2012); the same occurs to almost 45% of firms with regular PP in Norway during the reference period (2012-2014). Thus, having stressed that also the firms with regular PP contracts could be innovative, our analysis is focused on those involved in PPI, i.e. the firms whose innovative activities have been induced by PP contracts, because either explicitly required or important for the awarding of such contracts.

Table 2. Firms involved in PP and PPI: absolute values and percentages by size class*

	Italy (CIS 2012)				Norway (CIS 2014)			
	Small	Medium	Large	Total	Small	Medium	Large	Total
Total firms	13246	3636	1815	18697	2580	1972	422	4974
Firms with PP	3529	1040	568	5137	766	730	195	1691
Firms with PPI	423	217	194	834	199	168	59	426
Percentage of firms with PP (on total firms)	26.64	28.60	31.29	27.47	29.69	37.02	46.21	34.00
Percentage of firms with PPI (on firms with PP)	11.99	20.87	34.15	16.24	25.98	23.01	30.26	25.19

Source: own computations on CIS 2012 Italian and CIS 2014 Norwegian micro-data.
*Small: firms having between 10 and 49 employees. Medium: firms having between 50 and 249 employees. Large: firms with more than 249 employees.

As already stressed in Section 2.2, there is ample evidence that SMEs find it difficult to enter into the PP markets. CIS micro-data for Italy and Norway confirm this finding (cf. Table 2). Indeed, as for firms participating in PP, in both countries, the share is bigger for large firms than for those of medium-size and, especially, for small firms. Nevertheless, looking at the Norwegian firms involved in PPI, the differences between size classes are by far less pronounced: in fact, the share of

small firms with PPI (26%) is higher than that of medium-sized firms (23%) and not so far from that of large companies (30%). In Italy, instead, the percentage of firms with PPI is remarkably higher in large as opposed to smaller companies. This could suggest that, in Italy, SMEs are even more discriminated when PPI is taken into account. However, such a conclusion cannot be inferred from a simple (univariate) descriptive analysis. In order to ascertain this hypothesis, it is necessary to perform an econometric analysis able to control for other firm characteristics that are likely to affect the participation in PP and, then, the involvement in PPI activities (cf. Section 3.3).

Tables A.1 and A.2 in the appendix report the firms' distribution across the industries covered in our datasets, which are defined according to the two-digit NACE classification. In Italy the firms participating in the PP market are highly concentrated in two industries, *Construction* and *Trade*, followed, at a considerable distance, by *Water supply, waste, recycling* and *IT services, telecommunications*. However, it must be noticed that the ICT industry achieves a much higher share when PP contracts have involved innovative activities.

In Norway the level of industry concentration in the PP market is much lower than in Italy: along with *Construction* and *Trade*, there is a remarkable presence of ICT firms and a significant one for firms belonging to *Technical engineering, R&D, Other producer services, Transportation, postal services* and *Printing, publishing, media*. When PP contracts involving innovative activities are taken into account, a clear prevalence of ICT firms emerges. To summarize, in Norway the PP market involves more service firms than in Italy; however, when PPI is taken into account the firms providing ICT services record a remarkable presence also in Italy.

3.3 Econometric strategy

Moving to the econometric analysis, in a first step we estimate two probit regressions for PP and PPI by considering all the firms included in the CIS samples for Italy and Norway

$$PP_i = 1(\boldsymbol{X}_i'\beta + u_i > 0) \qquad [1]$$

$$PPI_i = 1(\boldsymbol{X}_i'\beta + e_i > 0) \qquad [2]$$

where the suffix *i* identifies firms.

This approach allows us to analyse and compare the factors affecting firms' access into PP market with those that specifically determine their participation in PPI. Indeed, firms involved in PPI are also confronted with all the other sampled firms, including those that have not entered the public procurement market.

However, we contend that it would be highly unlikely that a firm that does not have an adequate level of knowledge and procedural capabilities related to PP in general (see Section 2.2) would be able to obtain a PP contract for innovation. In other words, a firm interested in participating in a public tender that entails innovative activities, in any case must be able to access the public procurement market, irrespective of the content of the tender.

Accordingly, we perform a probit regression for PPI by restricting the sample to the firms engaged in PP (i.e. with PP=1), that is

$$PPI_i = 1(\boldsymbol{X}_i'\beta + \epsilon_i > 0) \;\; if \; PP_i = 1, \; missing \; otherwise \qquad [3]$$

Hence, in this case, we examine the firms' characteristics or strategies that facilitate their engagement in PPI conditional on their participation in PP and, thus, compared to those firms that only obtain regular PP contracts.

Nevertheless, to adopt an approach based on two separate but sequential estimations for PP and PPI could give rise to biased results due to the possible correlation between the error terms of equations [1] and [3] (i.e. u_i and εi respectively). In order to check if this is the case, a joint estimation is necessary. Therefore, as a robustness check, we also estimate the two equations by means of a Heckman sample selection model in which the firm characteristics or strategies that increase the PP participation are used to correct the estimation of the probability of being involved in PPI. Being based on two probit equations, the model must be estimated with Maximum Likelihood. Moreover, in the absence of reliable exclusion restrictions, we prefer to estimate the selection and outcome equations with the same set of covariates[4].

3.4 Explanatory variables

To evaluate the role of firm size we insert two dummy variables for *Small firms* (having between 10 and 49 employees) and *Medium-sized firms* (from 50 to 249 employees), with *Large firms* (250 employees or more) taken as reference category. To test hypotheses 1a and 1b, the size variables are included among the regressors of both probit equations.

To assess the influence exerted by cooperation with different external actors (hypothesis 2), we employ three binary indicators. The first two refer to firms' cooperation linkages for innovation with different types of partners: *Cooperation with universities and public research institutes*, equal to 1 if a firm has formal cooperation agreements with universities and public research institutes, and

[4] A Heckman sample selection model can be estimated without exclusion restrictions. In this case, however, identification is only achieved by exploiting the non-linearity of the model (cf. Escanciano et al., 2016), that is, via the functional assumptions regarding the bivariate distribution of the error terms.

0 otherwise; and *Cooperation with other external actors (suppliers, competitors, etc.)*, which takes value 1 if a firm is engaged in cooperation with at least two different types of other external actors among those listed in the CIS, namely suppliers, private clients, competitors and consultants. Then, we also consider a further dummy variable, termed *New methods of organising external relations*, aimed at capturing firms' attitude and efforts to undertake collaborations mainly with other enterprises. Indeed, this variable takes value 1 if a firm has increased the use of alliances, partnerships, outsourcing or sub-contracting.

Among the control variables, we consider five human capital dummies accounting for the percentage of employees holding a university degree (*Human capital 1-4%; Human capital 5-9%; Human capital 10-24%; Human capital 25-49%; Human capital 50% or more*, with *Human capital 0* taken as reference category). Moreover, we insert the binary indicator *Innovative activities mainly devoted to product innovations*, which takes value 1 if a firm has invested in at least two different innovative activities specifically aimed at the development of new products between intramural R&D, product design and marketing activities. Finally, we include in all the regressions the set of industry dummies reported in Tables A.1-2 in appendix.

4. Results

4.1 Firms' involvement in PP and PPI: separate probit estimates

Tables 3 and 4, respectively for Italy and Norway, show the results obtained by running separate probit regressions for the probability of participating in PP (columns I) and, then, of being in involved in PPI (columns II) by using the full samples of firms (equations [1] and [2]). In addition, the results obtained by testing the model for PPI on the samples restricted to firms with PP contracts (equation [3]) are reported in the last columns. All regressions include industry dummies, though the estimated parameters are not reported for the sake of brevity.

Starting from the core of our analysis and, particularly, from the role of firm size, a highly significant and negative association emerges, both in Italy and Norway, between being a small or medium sized-firm and PP participation (columns I): hence, strongly supporting our *Hypothesis 1a*, smaller firms are confirmed to be less able to get access into the PP market. For what concerns firms' engagement in PPI, the results reported in columns II show that a similar negative relation emerges in both countries: the only difference is that, in the Italian case (Table 3), the estimated parameters for small and medium-sized firms are both statistically significant, whilst for Norway (Table 4) the coefficient for medium-sized firms, though still negative, turns out not statistically significant.

Table 3 - Probit regressions: firms' involvement in PP and PPI – Italy (CIS 2012)

	PP	PPI (full sample)	PPI (restricted sample: if PP=1)
Human capital 1-4%	0.114***	0.177***	0.215***
	[0.029]	[0.059]	[0.073]
Human capital 5-9%	0.157***	0.141*	0.128
	[0.039]	[0.074]	[0.094]
Human capital 10-24%	0.138***	0.119*	0.110
	[0.036]	[0.070]	[0.088]
Human capital 25-49%	0.177***	0.294***	0.273***
	[0.043]	[0.075]	[0.099]
Human capital 50% or more	0.220***	0.313***	0.254**
	[0.042]	[0.073]	[0.100]
New ways of organising external relations	0.372***	0.578***	0.558***
	[0.029]	[0.042]	[0.055]
Small firms	-0.213***	-0.204***	-0.074
	[0.039]	[0.060]	[0.080]
Medium-sized firms	-0.112***	-0.124**	-0.032
	[0.041]	[0.061]	[0.083]
Innovative activities mainly devoted to product innovation	-0.065	0.093*	0.205***
	[0.042]	[0.053]	[0.076]
Cooperation with universities and public research institutes	0.245***	0.338***	0.286***
	[0.065]	[0.078]	[0.105]
Cooperation with other external actors (suppliers, competitors, etc.)	-0.003	0.021	0.055
	[0.068]	[0.081]	[0.110]
Industry dummies	yes	yes	yes
Constant	-0.773***	-1.542***	-0.674***
	[0.058]	[0.101]	[0.135]
Observations	18,697	18,697	5,137
Log pseudolikelihood	-9905.1284	-2590.6065	-1690.6493

Human capital 0 and *Large-sized firms* used as reference categories. Robust standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1.

However, it needs to be recalled that these results are to be interpreted with respect to all other firms included in the Italian and Norwegian samples under consideration, regardless of whether they have actually been able to enter into the PP market. By contrast, when the analysis is restricted to firms with PP contracts (columns III), results show that the size of the firms do not significantly discriminate between firms engaged in PPI and those that only obtain RPP contracts (i.e. not entailing any innovation activity): indeed, in both countries, the estimated parameters for small and medium-sized firms are not statistically significant (even though still negative in sign). Hence, a very important result that we find, in contrast with *Hypothesis 1b*, is that smaller firms are not less likely to undertake innovation as part of PP contracts. Accordingly, and to put it in a way consistent

with the adopted econometric strategy, it is possible to say that, once smaller businesses have managed to access the PP market, they are not less able to participate in PPI than their larger counterparts. This is perhaps because innovative SMEs can compensate for size-related disadvantages with greater adaptability and flexibility, which allow them to respond more rapidly to market demand, and also with a greater capacity to customise their products.

Table 4 – Probit regressions: firms' involvment in PP and PPI – Norway (CIS 2014)

	PP	PPI (full sample)	PPI (restricted sample: if PP=1)
Human capital 1-4%	0.023 [0.143]	-0.092 [0.222]	-0.113 [0.301]
Human capital 5-9%	0.229** [0.105]	-0.096 [0.157]	-0.321 [0.213]
Human capital 10-24%	0.311*** [0.094]	0.002 [0.136]	-0.237 [0.190]
Human capital 25-49%	0.296*** [0.099]	0.053 [0.146]	-0.202 [0.198]
Human capital 50% or more	0.348*** [0.101]	0.224 [0.149]	0.026 [0.201]
New ways of organising external relations	0.170*** [0.059]	0.282*** [0.074]	0.291*** [0.096]
Small firms	-0.432*** [0.072]	-0.214** [0.097]	-0.041 [0.117]
Medium-sized firms	-0.199*** [0.071]	-0.134 [0.095]	-0.129 [0.115]
Innovative activities mainly devoted to product innovation	0.209*** [0.050]	0.527*** [0.068]	0.559*** [0.090]
Cooperation with universities and public research institutes	0.097 [0.073]	0.490*** [0.091]	0.618*** [0.123]
Cooperation with other external actors (suppliers, competitors, etc.)	0.077 [0.068]	0.112 [0.089]	0.100 [0.118]
Industry dummies	yes	yes	yes
Constant	-0.637*** [0.126]	-1.855*** [0.190]	-1.105*** [0.253]
Observations	4,974	4,974	1,691
Log pseudolikelihood	-2938.8521	-1232.6598	-813.1894

Human capital 0 and *Large-sized firms* used as reference categories. Robust standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1.

Regarding the role of firms' external cooperation, our results confirm *Hypothesis 2* as we find that *Cooperation with universities and public research institutes* exerts a positive and highly significant influence on firms' involvement in PPI, both in Italy and Norway: this result holds either when estimations are carried out by employing the full samples of firms (columns II), or if the analysis is

restricted to firms with PP contracts only (columns III). This finding is in line with previous research highlighting the importance of public R&D actors as networking partners for PPI. Indeed, relationships with public research organisations may prove beneficial, especially for SMEs, by complementing their potential lack of internal resources and innovative capabilities necessary to compete successfully (Masiello et al., 2015). Interestingly enough, for Italian firms, the role played by this type of cooperation seems more pervasive as it is also positively and significantly associated with the probability to obtain a PP contract in general (i.e. irrespective of whether it entails innovation or not); however, it needs to be stressed the size of the coefficient is greater for PPI (column II), thus entailing a stronger relationship as expected. The variable *Cooperation with other external actors (suppliers, competitors, etc.),* instead, turns out with a not significant coefficient in all estimates. Hence, networks with other firms do not seem to improve neither the ability of firms to get access into the PP market, nor the likelihood that they undertake innovative activities related to PP contracts. This result, however, should be interpreted with caution as it might be due to the fact that the CIS survey only detects formal cooperation agreements: while the fundamental channel of transfer of scientific knowledge is through the establishment of formal relationships with those organisations that produce such knowledge, that is, universities and research centres, other types of knowledge, practical information and valuable resources to compete for public tenders are more likely to be drawn by means of repeated, though informal, exchanges with other firms. In accordance to this, and consistently with our second hypothesis, the dummy for *New methods of organising firms' external relation,* which is not exclusively related to (formal) cooperation for innovative activities, though still aimed at capturing firms' efforts towards establishing alliances with other firms, exhibits a positive and highly significant coefficient with respect to PP (column I) and PPI (columns II and III) in both countries. It is thus fully supported that, by increasing their external relations, firms get better chances to access the PP market and, most importantly, are more able to obtain PPI rather than RPP contracts.

Turning to controls, for Italy, all the listed indicators of human capital, each accounting for additional levels of endowment of graduated employees, turn out positively and significantly associated with firms' participation to PP as expected. We find a similar positive relation with respect to firms' involvement in PPI (columns II and III), even though some coefficients loose significance. On the whole, it is thus confirmed that a greater endowment of employees with tertiary education improves firms' ability, not only to enter into the PP market, but also to innovate via public contracts. As for Norway, we also find that all human capital dummies correlate positively and significantly with PP participation (exception made for the lowest level, i.e. *Human capital 1-4%),* whilst they are not significant at all for PPI. Hence, a greater endowment of highly educated

employees, although significantly discriminates between firms able to enter into the PP market or not, does not seem to increase the likelihood that firms will be involved in PPI. This result may be due to the fact that, in Norway, most firms with only RPP contracts are as innovative as those with PPI (cf. Section 3.2) and, hence, rely upon high shares of qualified workers. Moreover, this finding needs to be considered in the light of some limitations pertaining the available information on the level of education of the firms' employees. Indeed, given the data at our disposal, we can only differentiate between graduated and non-graduated employees and not even the type of degree (i.e. the field of study) or the exact level of study reached.

In line with expectations, the coefficient of the variable *Innovative activities mainly devoted to product innovation* is positive and significant with respect to PPI in both countries, although in Italy with less statistical significance when the estimation is carried out on the full sample of firms (column II). In this case, we also find a not significant relation with PP, which suggests that this variable more clearly discriminate between firms involved in PPI and those only engaged in RPP. In Norway, instead, it turns out positive and highly significant with respect to all the dependent variables of interest. Overall, however, it is confirmed that firms that innovate in products (goods and services) are more likely to be influenced by the public sector in their innovation activities compared to those more focused on process innovations (see also Uyarra et al., 2014). This result is consistent with the positive role emerged for cooperation with scientific organisations and, also, with existing empirical literature highlighting that the development of new products requires external knowledge and resources that can be best obtained through collaboration with academic researchers (e.g. Robin and Schubert, 2013).

4.2 Robustness check: Heckman selection model

Table 5 presents the results obtained by jointly estimating the two equations [1] and [3] via the Heckman sample selection model. As shown in the bottom lines of the table, the correlation coefficient between the error terms of equations [1] and [3] (i.e. athrho) is always significant, though positive in the Italian case and negative in that of Norway. Consistently, the hypothesis of independent equations is rejected by the Wald test, which indicates that the PP and PPI equations should be jointly estimated as they are affected by selection bias.

Nevertheless, in spite of sample selection, almost all the results (both in terms of sign and significance of the coefficients) are not substantially different from those arising from separate probit regressions (cf. Tables 3 and 4). Above all, they do not alter the extent to which our hypotheses are supported.

Table 5. Heckman Probit regressions with sample selection: firms' involvement in PP and PPI

	ITALY (CIS 2012)		NORWAY (CIS 2014)	
	PP (selection eq.)	PPI (outcome eq.)	PP (selection eq.)	PPI (outcome eq.)
Human capital 1-4%	0.114***	0.234***	0.025	-0.071
	[0.029]	[0.069]	[0.141]	[0.186]
Human capital 5-9%	0.157***	0.166*	0.237**	-0.317**
	[0.039]	[0.088]	[0.104]	[0.138]
Human capital 10-24%	0.137***	0.144*	0.328***	-0.345***
	[0.036]	[0.083]	[0.093]	[0.122]
Human capital 25-49%	0.176***	0.309***	0.306***	-0.332***
	[0.043]	[0.093]	[0.098]	[0.124]
Human capital 50% or more	0.219***	0.303***	0.364***	-0.239*
	[0.042]	[0.094]	[0.099]	[0.127]
New ways of organising external relations	0.375***	0.629***	0.168***	0.047
	[0.029]	[0.052]	[0.059]	[0.084]
Small firms	-0.215***	-0.134*	-0.413***	0.308***
	[0.039]	[0.075]	[0.072]	[0.095]
Medium-sized firms	-0.114***	-0.065	-0.183***	0.086
	[0.041]	[0.078]	[0.071]	[0.090]
Innovative activities mainly devoted to product innovation	-0.066	0.171**	0.206***	0.129
	[0.042]	[0.071]	[0.050]	[0.106]
Cooperation with universities and public research institutes	0.245***	0.339***	0.100	0.300***
	[0.066]	[0.100]	[0.073]	[0.109]
Cooperation with other external actors (suppliers, competitors, etc.)	-0.003	0.050	0.085	0.008
	[0.068]	[0.105]	[0.068]	[0.078]
Industry dummies	yes	yes	yes	yes
Constant	-0.771***	-1.230***	-0.662***	0.569**
	[0.058]	[0.147]	[0.125]	[0.235]
Observations	18,697		4.974	
Censored obs. (firms without PP contracts)	13.560		3.283	
Uncensored obs. (firms with PP contracts)	5.137		1.691	
Wald Chi2(1) test of independent equations (rho=0)	30.23***		9.11***	
athrho	0.497*** [0.090]		-1.795*** [0.595]	

Human capital 0 and *Large-sized firms* used as reference categories. Robust standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1.

Indeed, regarding the role of firm size, it is confirmed that smaller firms experience more difficulties in accessing the PP market both in Italy and Norway. As for Italy, notwithstanding the slight negative association emerged between being a small firm and PPI participation, the results show that medium-sized firms that have managed to get access into the PP market are not less able than large firms to undertake innovative activities related to PP. In Norway, small firms seem even advantaged in undertaking innovation related to PP contracts compared to their larger counterparts,

while the estimated parameter for medium-sized firms is still positive but not statistically significant.

The findings concerning the influence of cooperation with different external actors are also consistent with those already discussed. In particular, the positive and highly significant role of cooperation with universities and public research institutes with respect to firms' involvement in PPI is fully confirmed for both countries. In this case, the only difference regards the insignificant parameter emerged for the variable *New ways of organising external relations* with respect to PPI, though only for Norwegian firms.

Another difference with respect to previous findings regards the variable *Innovative activities mainly devoted to product innovation* that, only for Norway, reveals a not significant coefficient with respect to PPI, which might be due to the aforementioned circumstance that, in this case, a higher share of firms with only RPP contracts are as innovative as those involved in PPI. Notwithstanding this, it is confirmed that Norwegian firms that innovate in products are more likely to obtain a PP contract. Hence, according to the results obtained by the joint estimation, being involved in innovative activities aimed at developing new products actually discriminates between firms engaged in PPI and those that only obtain RPP contracts in the Italian case only.

5. Concluding remarks

The empirical analysis carried out in this paper contributes to shed light on which factors are more likely to increase firms' propensity to undertake innovative activities as part of PP contracts. By controlling for factors affecting the participation in the procurement market, our main findings highlight important differences between firms engaged in PPI and those taking part only in RPP activities. These especially regard the role of firm size: the evidence provided confirms that for SMEs, as opposed to large companies, it is more difficult to enter into the PP markets; however, once they have managed to do so, they are not less able to innovate and, then, to offer innovative solutions to public buyers than large firms. Another major result regards the beneficial role of firms' cooperation with different external actors: especially strengthening the relationships with scientific institutions seems to play a key role in order to facilitate firms' involvement in PPI. Although based on cross-sectional data (not allowing to appropriately deal with problems of endogeneity), we contend that these results are not only interesting, but also sufficiently robust in that they arise from two very different economic and institutional contexts: Italy and Norway. In this respect, it must be remarked that different findings for Italy and Norway could be expected for several reasons, such as the different propensity of firms to perform innovative activities and the different quality and competences of public administrations. Most importantly, in the years under

examination, the Norwegian government had already adopted a comprehensive public procurement strategy for innovation while in Italy more efforts had been devoted to foster small firms' participation in PP markets. Notwithstanding this, we found that the differences between the two countries are limited to the extent of the effect exerted by some explanatory and control variables.

Overall, the evidence provided calls for more effective policy initiatives aimed at fostering the diffusion of public procurement as a demand-side instrument to incentivise and support firms' innovativeness. For instance, the possibility of making PP contracts for innovation (especially by using functional specifications), which has been allowed by the EU Procurement Directives of 2014, should be more publicized among procurement agencies, with particular regard to those of regional and municipal governments. Then, a further activity that should be undertaken is the training of public officials involved in PP, with a view of reducing their risk aversion and increasing their ability to draw and manage PPI contracts.

Levelling the playing field for public procurement represents a clear policy priority: on this, our results reinforce the need of reducing the barriers that prevent SMEs to enter into the PP market and win public tenders. Therefore, policy measures that specifically target the promotion of small firms' involvement in PP, and particularly, in PPI are advisable. In this respect, an important challenge is represented by the spread of knowledge, as smaller firms do not often have enough information about how to participate in public tenders and even where to look for such information. As a consequence, they are not aware of the potential advantages of public procurement for innovation as a mean to increase the provision of new goods and services to public administrations. In addition, Timmermans and Zabala-Iturriagagoitia (2013) have proposed "coordinated unbundling" as a method to break down large tenders. We agree that to divide procurement contracts into smaller parts, or to break down tenders geographically, could be useful in order to "provide stimuli to smaller organisations to participate and thereby, indirectly, reserving spots for them in the procurement process." (ibid., p.6). Finally, in addressing these issues, the potential differences within the same group of SMEs, that is, between small and medium-sized firms, could be taken into account as such firms might also vary in their tendering resources and capabilities.

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Appendix A

Table A.1.Firms involved in PP and PPI: percentages by industry - ITALY (CIS 2012)

	NACE (Rev. 2)	% of all firms	% of firms with PP	% of firms with PPI
Food, beverages, tobacco	10,11,12	2.6	0.7	0.6
Textiles, clothing	13,14,15	2.7	0.4	1.0
Wood, paper	16,17	1.6	0.9	1.1
Chemicals, pharmaceuticals	20,21	1.3	1.1	0.8
Rubber, plastics	22	0.9	0.4	0.5
Glass, ceramics, concrete	23	1.0	0.8	0.5
Metals	24,25	3.0	1.5	2.3
Electronics, electrical	26,27	1.5	1.6	4.2
Machinery, equipment	28,33	3.1	2.0	2.6
Vehicles	29,30	1.2	0.8	2.4
Furniture, other manufacturing	31,32	1.5	0.7	0.6
Energy, mining, oil	9,19,35	2.7	3.3	2.8
Water supply, waste, recycling	36,37,38,39	3.5	6.4	8.3
Construction	41,42,43	23.3	38.1	22.7
Trade	45,46,47	28.9	20.9	16.2
Transportation, postal services	49,50,51,52, 53	7.3	4.9	5.3
Printing, publishing, media	18,58,59,60	1.3	1.6	1.4
IT-services, telecommunications	61,62,63	3.3	4.7	13.1
Financial intermediation	64,65,66	3.6	2.9	5.4
Consulting, advertising	69,70,73	2.6	2.3	1.9
Technical engineering, R&D	71,72	1.5	2.4	4.1
Other producer services	74	1.5	1.4	2.4

Source: own computations on CIS 2012 Italian micro-data

Table A.2. Firms involved in PP and PPI: percentages by industry - NORWAY (CIS 2014)

	NACE (Rev. 2)	% of all firms	% of firms with PP	% of firms with PPI
Food, beverages, tobacco	10-12	6.7	3.1	3.8
Textiles, clothing	13, 14-15	1.1	0.9	0.7
Wood, paper	16,17	2.5	1.5	0.9
Chemicals, pharmaceuticals	19-20, 21	1.5	1.2	1.4
Rubber, plastics	22	1.0	0.7	0.5
Glass, ceramics, concrete	23	1.5	1.1	0.9
Metals	24,25	4.8	2.8	3.1
Electronics, electrical	26,27	2.6	2.5	4.0
Machinery, equipment	28,33	4.8	3.5	3.1
Vehicles	29,30	2.5	1.6	1.9
Furniture, other manufacturing	31,32	1.3	1.2	1.6
Energy, mining, oil	5-9,35	5.6	3.6	2.8
Water supply, waste, recycling	36, 37-39	2.4	3.5	3.5
Construction	41,42,43	9.7	14.7	9.2
Trade	46	8.6	11.1	7.5
Transportation, postal services	49,50,51,52,53,79	7.6	6.3	3.5
Printing, publishing, media	18,58,59-60	6.0	6.4	8.2
IT-services, telecommunications	61,62-63	7.2	11.5	19.7
Financial intermediation	64,65,66	3.5	3.1	2.8
Consulting, advertising	69-70, 73	2.1	2.8	4.2
Technical engineering, R&D	71,72+75	7.1	8.6	9.4
Other producer services	74,82,55-56	9.9	8.2	7.3

Source: own computations on CIS 2014 Norwegian micro-data.