The Role of Buyer Power in Public Procurement Auctions: An Empirical Analysis

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ABSTRACT

Throughout the world, green public procurement (GPP) has become an established environmental policy instrument. Advocates of this purchasing policy argue that the public sector can use its buyer power to incentivize industries into becoming less environmentally damaging. I study how GPP is organized in Sweden and the potential supplier's response to varying buyer market shares. The level of GPP stringency is found to vary systematically with authority type, buyer market share, and political coalition in the relevant council or the Swedish Parliament. The results indicate quite substantial dispersion in GPP stringency and suggest a low degree of coordination when implementing the policy. After controlling for GPP stringency and other covariates, buyer market share is positively associated with the probability of potential suppliers submitting a bid.

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1. Introduction

Green public procurement (GPP) is increasingly seen as an instrument of environmental policy (Testa et al., 2012). Proponents of GPP argue that public authorities can "*be a major driver for innovation, providing industry with real incentives for developing green products and services – particularly in sectors where public purchasers represents a large share of the market (e.g. construction, health services or public transport)*" European Commission (2011, p. 5). Using detailed field data on internal regular cleaning service contracts, the overall objective of this paper is to study the organization of GPP across various contracting authorities and regional markets and the effect of buyer market share on the potential supplier's probability of submitting a bid.

There is a scarcity of empirical research on the importance of buyer market share when designing GPP criteria. However, the theoretical literature might provide some guidance regarding the significance of buyer market share in GPP. In a partial equilibrium framework, Marron (1997; 2003) studied the effects on total production when the public sector switched from buying a conventionally produced product to a greener off-the-shelf product. The public sector being a large, coordinated buyer in both markets was identified as one of three conditions for the policy to actually have a positive environmental effect.[2] Lundberg et al. (2014) extended the analysis of Marron (1997) by introducing a transformation policy with the intention to create direct incentives for conventional potential suppliers to adjust their production technology according to the GPP criteria and enter the procurement auction process. A transformation policy is predicted to reduce conventional production and increase green production more effectively if the public sector is a large buyer in both markets.

Indeed, the public sector is a significant buyer in many sectors of the economy. In the European Union, public procurement of goods, works, and services is estimated to account for 16% of the GDP (European Commission, 2008b). It must be emphasized, however, that this crude estimate of buyer market share aggregates procurement decisions made by numerous distinct authorities – including municipalities, county councils, public enterprises, and central governments – over several product and service categories. Even centralized governments consist of various agencies making independent procurement decisions. Hence, full utilization of the public authorities' buyer power potential in a given sector may require demand coordination, either implicitly through a low degree of heterogeneity in buyer preferences or explicitly through standardization across different contracting authorities (Marron, 2003; Edler and Georghiou, 2007; Albano and Sparro, 2010). This, of course, limits the scope for a flexible GPP design in accordance with the general market structure or the contracting authority's idiosyncratic preferences, including its valuation of local externalities in production (Marron, 2003; Albano and Sparro, 2010). Hence, there is a potential tradeoff between market power

[2] Other factors for the ability of GPP to contribute to reduced environmental impact are price elasticity of supply and private demand in both markets.

through coordinated demand on the one hand and flexibility on the other.[3] This study adds to the existing literature by using cross-sectional variation in buyer composition to assess the degree of coordination when implementing GPP.

Despite the frequent use of GPP (see, for example, Palmujoki et al., 2010), the understanding of buyer power in this setting is far from complete. This paper uses field data on more than 700 internal regular cleaning contracts awarded by 176 distinct Swedish contracting authorities between December 2008 and December 2010. A motivation for the data under study is the European Union's recognition of cleaning products and services as being particularly suitable for GPP.[4] Furthermore, internal regular cleaning contracts make a good testing ground because these are highly homogenous services being both produced and consumed locally and because they are a basic necessity in both the public employment sector and the private employment sector. These characteristics are utilized when constructing proxy variables of buyer market share, which is defined as the share of the workforce in the regional market being employed by the public authority.

In total, 28 green criteria were identified in the data. In several previous studies, contract complexity has been proxied by using the total number of criteria in the tender notice (see, for instance, De Silva et al., 2009; 2012), and the number of GPP criteria is used in this paper as a measure of GPP stringency. This approach differs somewhat from previous studies using the same dataset. More specifically, Lundberg et al. (2015) analyzed the effect of GPP criteria on the probability of entry and qualification across firm size by grouping the 28 green criteria into six dummy categories based on similarity. The simple method of aggregating GPP criteria employed here is admittedly not ideal because it does not reflect that individual criteria may have an adverse impact on the potential supplier's entry decision, as indicated in Lundberg et al. (2015). Nevertheless, in the current context this simple index is useful for exploring possible systematic differences in the organization of GPP across contracting authorities and regional markets of different buyer composition.

In this paper, I study three questions. First, does the contracting authority acknowledge its buyer market share when assigning GPP stringency? Second, to what extent does the public sector exercise its potential buyer market power through coordinated implementation of GPP? Third, is there an effect of buyer market share on the potential supplier's entry decision?

This study is foremost related to three main areas within the literature. First, there is a body of literature seeking to identify determinants for the various contracting authorities' use of GPP criteria, often referred to as GPP-uptake (see, for example, Walker and Brammer, 2009; Palmujoki et al., 2010; Testa et al., 2012). Information campaigns, e-procurement, communication with suppliers, and education of civil servants are typically indicated in these studies to be associated with increased

[3] See Albano and Sparro (2010) for a non-technical discussion on the optimal degree of centralization.
[4] http://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm.

probability of using environmental criteria in the call for tender. The current study is concerned with the contracting authorities' response to cross-sectional variation in buyer market share, conditional on voter preferences for environmental questions, average wage level, and other observable factors that in theory may affect the level of GPP stringency.

A second body of literature related to the present paper is concerned with governments promoting innovation through the demand side of the market, which is often referred to as the market-pull approach (see, for example, Marron, 2003; Edler and Georghiou, 2007; and Albano and Sparro, 2010). These theoretical studies emphasize the importance of the contracting authority holding adequate buyer power in the relevant market such that it constitutes a so-called lead market of its own. Buyer power is argued to either stem from the sheer size of a single purchase or from coordinated actions across several contracting authorities. However, demand coordination might come at the cost of reduced buyer surplus due to, for instance, heterogeneous buyer preferences. No previous studies have, to the author's knowledge, used cross-sectional variation in buyer composition across regional markets to quantify the degree of coordination when implementing GPP.

The third field of interest in the literature is related to the supplier's response to variation in buyer market share in the context of GPP. Lundberg et al. (2015) have empirically studied the effect of different categories of green criteria on the potential supplier's probability of entry and qualification by using the same data as in this paper. The effect on entry was shown to be statistically insignificant in general.[5] However, several green criteria appear to be associated with increased complexity, as indicated by the reduced probability of a bid being qualified in the post qualification process. By assessing the effect of buyer market share on the probability of potential suppliers submitting a bid for public contracts, the current paper also contributes to previous literature on endogenous entry into auctions (see, for instance, Samuelson, 1985; Levin and Smith, 1994; Jofre-Bonet and Pesendorfer, 2000; 2003; Li and Zheng, 2009; Krasnokutskaya and Seim, 2011).

Among the results, a count regression with GPP stringency on buyer market share and other observable buyer characteristics indicates heterogeneities in the level of GPP stringency across authority types. A high level of GPP stringency is used more often in regional Swedish markets where the contracting authority type has a large buyer market share and when the Swedish Green Party holds the balance of power in the relevant council of the contracting authority or in the Swedish Parliament. Results from a cross-sectional analysis of GPP dispersion as a function of public buyer composition suggest that the organization of GPP is less dispersed (i.e. there is a higher degree of demand coordination) in more concentrated markets in terms of authority types. Consistent with theoretical predictions, logit estimates suggest a positive significant direct effect from increased buyer market on

[5] The one exception is environmental management systems, such as different ISO 1400 standards, and these are found to have a significant negative effect on entry.

the probability of potential suppliers submitting a bid. The effect persists even after taking into account the indirect effect of buyer market share mediated by GPP stringency.

The rest of this paper is organized as follows. Section 2 gives an overview of the institutional background of GPP in the European Union and Sweden. Section 3 accounts for the main findings emerging from the literature related to the hypothesis of the study. Section 4 presents the dataset and the measurements of variables, and section 5 outlines the empirical approach. Section 6 presents the estimation results, and section 7 concludes the paper.

2. Institutional background of public procurement in the European Union and Sweden

Outsourcing of public contracts is usually done by means of a descending first price sealed bid auction in which potential suppliers are invited to enter a bid in accordance with the specification in the call for tender. A call for tender includes a technical specification of the quality criteria to be fulfilled by the bidder, contractual terms, and the supplier selection method. A particular procurement may include one or several contracts that are all identical with respect to letting date, supplier selection method, and quality criteria to be fulfilled. Bidding is simultaneous and independent across contracts in the same procurement, and these are also known as stand-alone bids.

Principles for supplier selection can either be lowest price, given the quality criteria, or the most economically advantageous tender (MEAT). MEAT means that all qualified bids are ranked according to a multidimensional scoring rule that includes price and other quality and potentially green attributes (Asker and Cantillon, 2008; Lewis and Bajari, 2011; Lundberg and Marklund, 2011; Bergman and Lundberg, 2013). After the letting date, the contracting authority screens all received bids against the quality criteria specified in the call for tender. Only bids that meet the criteria are qualified for bid evaluation on the basis of the supplier selection method. In the standard case of stand-alone bids, the contract is awarded to the highest-ranked qualified bidder, which is compensated in accordance with her price-bid.

GPP means that contracting authorities stipulate and consider green criteria in the contract award in addition to quality criteria.[6] Green criteria may specifically address aspects of the supplier's production technology such as environmental management systems, references proving sustainability, certificates, standards, biodiversity, emissions into the air and water, energy and water consumption, chemical consumption, and waste generation (European Commission, 2011).

Legislation and recommendations regarding public procurement, including GPP, are centralized at the European Union level where one of the main objectives for public procurement is to promote a true

[6] GPP is described as a policy "*whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured.*" European Commission (2008b, p. 5).

unification of the internal market (see, for example, Albano and Sparro, 2010, and references therein). The ambition to stimulate GPP uptake has led to the development of a common set of GPP criteria such as "eco-labels" (e.g. European Eco-label, see Rüdenauer et al., 2007, European Commission, 2008b, and Testa et al., 2012), and these criteria also work towards increased demand coordination across contracting authorities and member states (European Commission, 2008a).

The implementation of GPP is voluntary and made at the discretion of the various local contracting authorities in each member state that are subject to procurement laws (that is, local governments, central governments, and public enterprises). In Sweden, public goods and services are provided by three levels of government. Specifically, municipalities and county councils[7] constitute different levels of local government, and the central government constitutes the national level. Allocation of seats to the political parties in the municipal council, county council, or the Swedish Parliament is made according to the principle of proportional representation on the basis of general elections that are held every four years. There is a clear division between socialist and non-socialist parties resulting in a fairly stable two-bloc system (see, for example, Pettersson-Lidbom, 2008).

3. Buyer power and GPP

3.1 Buyer size, demand coordination, and GPP stringency

Theory on the market response to GPP predicts that the purchasing policy's ability to contribute to reduced environmental impact critically depends on the relevant buyer market share of the contracting authority as well as the price elasticity of supply and private demand. More specifically, in a partial equilibrium framework Marron (1997) analyzed private market response to the public sector switching from buying a conventionally produced product to a greener counterpart. In the standard case of increasing marginal costs of production, GPP is predicted to induce a counteracting effect from the private consumers, and the policy can reduce environmental impact more effectively in procurement sectors where *i*) the public sector has a large market share in both markets, *ii*) the supply is price elastic in both markets, and *iii*) the private demand is inelastic in both markets. Lundberg et al. (2014) extended the analysis of Marron (1997) by considering the procurement process and the incentives it creates for conventional potential suppliers to adjust their production technology according to the GPP criteria and submit a bid. Again, the GPP policy is more effective in reducing conventional production and increasing green production if the public sector is a large buyer in both markets and that conditions *ii* and *iii* also hold. Based on the theoretical predictions made in Marron (1997) and Lundberg et al. (2014), GPP stringency in public contracts is expected to increase in the contracting authority's buyer market share.

[7] The county council is a local government authority that is primarily responsible for providing health care.

Related to buyer power in public procurement is the degree of coordination when implementing the policy. Buyer power and supplier incentives are not well studied in the auction literature. However, theoretical results from the industrial organization literature indicate that a large buyer is better at creating incentives for potential suppliers to modify their existing technology according to the buyer's preferences (Inderst and Wey, 2007). Along the same line, two buyers with slightly heterogeneous preferences may want to enhance their bargaining power by coordinating their demands through single-sourcing contracts. Potential suppliers anticipating further concentration will respond strategically by choosing to produce less differentiated products, which intensifies supplier competition (Inderst and Shaffer, 2007).

Results from the bargain solution in Inderst and Wey (2007) and Inderst and Shaffer (2007) indicate that a successful implementation of GPP in terms of creating incentives for conventional potential suppliers to adjust their production technology according to the GPP criteria may require some degree of demand coordination across the various contracting authorities in the relevant market. In practice, this can be accomplished by means of coordinated actions across contracting authorities or through a central purchasing agency (Edler and Georghiou, 2007; Albano and Sparro, 2010). As noted by Albano and Sparro (2010), increased standardization may come at the cost of reduced buyer surplus of the individual contracting authority if buyer preferences, including their valuation of local externalities in production[8], are heterogeneous. Standardization also limits the possibility of fine tuning GPP criteria to regional market structures such as variations in the initial environmental performance among the existing pool of potential suppliers. Armed with these insights, it is not obvious what to expect in practice regarding the degree of coordination when GPP is implemented across regional markets of varying buyer composition.

3.2 Buyer power and supplier incentives in GPP

A distinctive feature of GPP compared to other policy instruments such as taxes or regulations is the optionality for potential suppliers to participate in the bidding process. As a concrete example, consider the following situation of a contracting authority introducing more stringent GPP criteria than is conventional in the market. A conventional potential supplier, which by definition does not comply with the GPP criteria, has the outside option of not adjusting its production process and instead going on to compete for the residual demand in the conventional market. Thus, paramount for analyzing the incentive structure of GPP is the potential supplier's decision to comply with the criteria and to submit a bid. It is reasonable to depart from a risk-neutral potential supplier that is assumed to bid for a contract whenever the expected profit of the contract, net of opportunity cost, is greater than or equal to the costs of entry (see for instance Samuelson, 1985; Levin and Smith, 1994; Li and Zheng, 2009;

[8] For instance, externalities associated with eutrophication or wastewater treatment may be site-dependent and thus differ across regions (see Finnveden and Nilsson (2005) and Lavee (2013) for a study on site-dependent externalities in Sweden and Israel, respectively).

Krasnokutskaya and Seim, 2011 for endogenous entry). Entry costs are usually attributable to preparing bid documents or learning the supplier's costs of fulfilling the contract, and in the context of GPP these can be extended to take into account supplier-specific compliance costs (Lundberg et al., 2015).

Previous empirical literature on auctions is more silent about variation in the relevant buyer market share of the auctioneer and what effect it may have on the potential supplier's incentives to enter the bidding process. Rather, buyer market share is implicitly assumed to be held constant across auctions and regional markets. For a standard discrete choice model, this translates into the opportunity cost of entering a buy or sell auction being normalized to a constant, usually zero[9,10] (Bajari et al., 2010). Based on theoretical work by Inderst and Wey (2007), this assumption may not be appropriate when the potential suppliers are capacity constrained or have strictly convex costs in production. In such circumstances, a large buyer having preferences for green attributes can lower the value of the conventional potential supplier's outside option more than if a small buyer were to have preferences for green attributes.[11] A large buyer may therefore, induce the potential suppliers to undertake a strictly higher investment cost associated with GPP criteria relative to a small buyer. Although predictions from the bargaining solution for menu contracts presented in Inderst and Wey (2007) might not necessarily be generalizable to a procurement auction, they can be paraphrased in relation to the current setting: The potential supplier's opportunity cost of entering a public contract may decrease in the buyer market share of the contracting authority.

A conventional supplier's outside option can, in this case, refer to competing procurement auctions within the relevant product market being organized by private consumers, but potentially also by competing public contracts of lower GPP stringency. Hence, the presence of an outside option will decrease the potential supplier's incentives to comply with stringent GPP criteria and commit capacity for a nontrivial period of time. Also, in a dynamic setting with differentiated GPP stringency the buyer market share can be of importance because the potential supplier's decision to comply with GPP criteria is not only a function of the expected profit of the current contract, but is also a function of the discounted stream of expected profits from future GPPs organized by the same contracting authority. All else being equal, a large contracting authority may therefore, provide the potential suppliers with stronger incentives to comply with stringent GPP criteria and enter the auction.

[9] Jofre-Bonet and Pesendorfer (2000, 2003) have modeled a dynamic auction game by taking the suppliers' capacity backlog into account.
[10] Krasnokutskaya and Seim (2011) control for unobserved heterogeneity in the competitive environment by including dummy variables for the various districts.
[11] This holds when industry profits are strictly concave in the number of suppliers, see Inderst and Wey (2007).

4. Data

The remainder of this paper examines buyer power in the context of GPP using data from internal regular cleaning service contracts awarded by Swedish public authorities between December 2008 and December 2010. The simplicity of the service makes it suitable for being tendered to an external service provider (Christoffersen and Paldam, 2007; Hyytinen et al., 2015), and market penetration is, therefore, likely to be high (Rüdenauer et al., 2007). Information about the procurements was gathered from a national database in which call-for-tender notices are advertised in Sweden.[12] Additional information given by the technical specification, the tender compilation, and records of the procurement decision was extracted from procurement documents. The dataset under study is extensive and highly homogenous regarding both context and timing of the auctions, and this eliminates the problem of differing GPP criteria over time.

The demand side of the data consists of 338 procurement auctions comprising 725 contracts organized by 176 distinct contracting authorities, whereas the supply side is represented by 4,648 bids placed by 341 unique potential suppliers. The data include detailed information on the type of facility to be cleaned, contract size, quality criteria, green criteria, and the identity of all bidders. Additional information on number of employees per authority type in the relevant market as well as other market and supplier characteristics was retrieved from Statistics Sweden. A single procurement auction may include one or several contracts all ruled by the same specification in the call for tender. In such cases, only the type of facility to be cleaned, the contract size, and the location differ across contracts. For a given procurement, a potential supplier decides whether to submit a bid for one or several contracts, thus the summary statistics are reported at the contract level.

Covariates included in the analysis are categorized into buyer characteristics (W), supplier characteristics (X), contract characteristics (Z), and market characteristics (N). According to the contracts studied here, the public sector accounts for 26.5% to 56.1% of the workforce in the regional market (see Section 4.1 for a definition of regional market). The public sector thus has the potential to influence the internal regular cleaning sector into using production processes perceived by the buyer (i.e., the regulator) as being less environmentally damaging. The potential environmental impact of internal regular cleaning services spring from the use of detergents, which can cause air pollution, ground-level ozone formation, or hazardous effects on the aquatic environment, as well as the services' waste generation and use of water and energy (Rüdenauer et al., 2007).

[12] Visma Commerse AB. This is the largest such database in Sweden and it covers approximately 90% of all procurements.

4.1 Buyer characteristics (*W*)

The vector *W* includes variables on buyer characteristics. Public buyers are classified into variables for municipality (*MUNI*), county council (*COUNTY*), governmental authority (*GOV*), and public enterprises (*PE*). As seen in Table 1, municipalities and central government are the most frequent authority types in the data and they represent 93% of the contracts.

Constructing a measure of buyer market share requires a proper definition of the relevant product market and geographical market. This can be done by identifying both buyers and suppliers whose demand and supply decisions determine the auction clearing price (Blair and Harrison, 2010). Internal regular cleaning services are demanded by both public authorities as well as private organizations, and the relevant product market is argued to include both the public and the private employment sector in the economy. Moreover, due to the decentralized structure of public procurement, various contracting authorities can compete with each other over potential suppliers. Internal regular cleaning is a service that is produced and consumed locally, and relevant geographical markets are determined by considering transportation cost for potential suppliers (Blair and Harrison, 2010). Here it is argued that a labor market area (LMA), as defined by Statistics Sweden, is the appropriate definition of a geographical market because it is based on observed commuting patterns of workers in Sweden and thus forms a homogeneous area of commerce. The variable for buyer market share (*BS*) is the share of the workforce in a given geographical market that is employed directly by the particular authority type (*MUNI*, *COUNTY*, *GOV*, or *PE)* that is organizing the procurement. As seen in Table 1, buyer market share ranges from 0.4% to 29.7% with an average value of 12.4%.

The variable *REPR* measures the proportion of seats in the municipal council, county council, and Swedish Parliament held by the Green Party. The proportion of seats held by a particular party has been used in the literature (see e.g. De Haan and Sturm, 1994) and serves as a proxy for voter preferences on environmental questions, but in this case it is also a measure of the Green Party's indirect influence in the policy-making process. To indicate whether the Green Party has any direct influence on the policy-making process, an indicator variable taking a value of one if the Green Party holds the balance of power (*BPOW*) in the relevant council or the Swedish Parliament is constructed. That is, if the socialist parties or non-socialist parties can form a majority only with the support of the Green Party. About 12% of the contracts originate from contracting authorities in which the Green Party has the balance of power.[13] Yet another buyer characteristic that will be included in the vector *W* is the variable for the average annual wage (*WAGE*) in Swedish Krona among residents in the LMA who are older than 16 years.

[13] Consistent with the data, public enterprises are assumed to be governed by the municipal council.

Table 1. Summary statistics of buyer characteristics, supplier characteristics, and market characteristics.

Variable	Median	Mean	Std. dev.	Min.	Max.	#
Buyer Characteristics (W)						
Municipality (*MUNI*)	1.00	0.52	-	0.0	1.0	725
County council (*COUNTY*)	0.00	0.05	-	0.0	1.0	725
Governmental authority (*GOV*)	0.00	0.41	-	0.0	1.0	725
Public enterprises (*PE*)	0.00	0.02	-	0.0	1.0	725
Buyer share, percent (*BS*)	11.39	12.42	7.20	0.4	29.7	725
Green Party representatives, percentage (*REPR*)	5.44	5.17	2.04	0.0	9.9	725
Green Party holding balance of power (*BPOW*)	0.00	0.12	-	0.0	1.0	725
Annual average wage in the LMA, 1,000 Krona (*WAGE*)	230.48	243.36	26.76	204.1	283.1	725
Supplier Characteristics (X)						
Entry decision (*ENTRY*)	0.00	0.12	-	0.0	1.0	31,139
Class size (*SIZE*)	5.00	5.29	3.55	0.0	16.0	31,139
Limited liability firms (*LTD*)	1.00	0.86	-	0.0	1.0	31,139
Headquarters is within the same LMA as the delivery site (*HEADQ*)	1.00	0.72	-	0.0	1.0	31,139
Market Characteristics						
Number of potential suppliers per LMA *(N)*	26.00	67.59	72.10	2.0	174.0	725

Notes. Summary statistics are weighted by the number of observations and are not necessarily representative of Sweden as a whole.

4.2 The set of potential suppliers

In accordance with the market definition of the demand side in Section 4.1, a potential supplier is assumed to exert a competitive pressure in all contracts within the LMA if it has entered a bid at least once during the two years from which the observations were sampled.[14] As seen in Table 1, the average number of potential suppliers *(N*) is 67.6 per contract.

Table 1 also reports a vector of supplier specific characteristics, *X*, to be included when modeling the potential supplier's entry decision. About 12% of the set of potential suppliers submit a bid (*ENTRY*) on average. Based on the definition of Statistics Sweden, register data on firm size (*SIZE*) is divided into 16 categories based on the number of employees.[15] The average potential supplier observed in the data is, according to the market definition employed here, a firm of about *SIZE* 5, which correspond to 20–49 employees. A majority of the potential suppliers (86%) are limited liability firms (*LTD*), and 72% of the potential suppliers' headquarters are located within the same LMA as the delivery site (*HEADQ*).

[14] This measure may suffer from a degree of measurement error because cleaning firms might go in or out of business or LMAs during the sample period.
[15] See Table A1 in the Appendix for more information on the distribution of firm size.

4.3 Contract Characteristics (*Z*)

Contract characteristics, denoted by *Z*, include a wide range of covariates, including green criteria and quality criteria. In total, 28 green criteria and 26 quality criteria are were identified from the procurement documents. These were defined as binary variables taking a value of one if specified in the call for tender and zero otherwise (see Appendix, Table A2 for descriptive statistics of the full set of green and quality criteria). In several previous studies, contract complexity has been proxied by using the total number of criteria in the tender notice (see for instance, De Silva et al., 2009; 2012). In this study, quality stringency is operationalized by counting the number of quality criteria in the tender notice. Environmental stringency in public contracts is operationalized by counting *i*) the number of GPP criteria defining voluntary environmental functions or attributes for products and services (*GPI*) and *ii*) the number of criteria that refer to existing Swedish public environmental regulations (*ENVREG*). Examples of voluntary GPP schemes include environmental management systems such as various ISO-certificates, eco labels, eco driving, etc. (see Appendix, Table A2 for the categorization of GPP criteria and other green criteria that refer to public environmental regulations).

A motivation for the two-dimensional measure of green stringency in public contracts is the European Union's ambition of reduced environmental impact through GPP (European Commission, 2008b). Complying with green criteria referred to in Swedish public regulations is a basic condition for doing business in Sweden, and is therefore expected to play only a minor role in the entry decision of potential suppliers. The distribution of the variable *GPI* is illustrated in Figure 1, and there are on average four GPP criteria per contract as seen in Table 2.

Figure 1. Kernel density estimates of GPI.

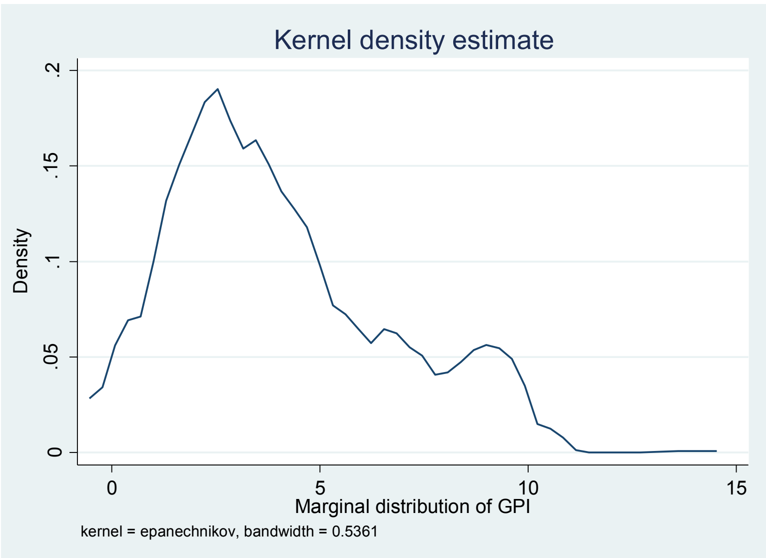


Table 2 presents summary statistics for the variables of green criteria referring to public regulation (*ENVREG*) and quality (*QINDEX*). There is on average one green criterion per contract referring to *ENVREG*, and *QINDEX* takes an average value of 10.7 quality criteria per contract. Other criteria that have been partitioned out from the indices are contractual terms stating that the contracting authority intends to follow-up that contractors actually deliver according to the green criteria (*EMON*) and the quality criteria (*QMON*) specified in the call for tender. It is less common that a contracting authority signals that it intends to follow-up on green criteria (9%) compared to quality criteria (88%).

Table 2. Summary statistics of contract characteristics.

Variable	Median	Mean	Std. dev.	Min.	Max.	#
Contract characteristics (Z)						
GPP stringency (*GPI*)	3.00	4.01	2.62	0	14	725
Public regulation index (*ENVREG*)	1.00	1.03	1.07	0	5	725
Planned environmental follow-up (*EMON*)	0.00	0.09	-	0	1	725
Quality index (*QINDEX*)	10.00	10.66	2.74	2	18	725
Planned quality follow-up (*QMON*)	1.00	0.88	-	0	1	725
Periodic floor cleaning (*FLOOR*)	1.00	0.73	-	0	1	725
Periodic window cleaning (*WIN*)	1.00	0.55	-	0	1	725
Area to be cleaned, square meters (*#SQMC*)	2,585.00	9,316.59	27,238.92	27	403,658	725
Number of contracts (*#CONTR*)	4.00	9.74	12.73	1	51	725
Number of delivery sites, municipalities (*#SITES*)	1.00	1.16	0.60	1	4	725
Supplier selection method (*MEAT*)	1.00	0.53	-	0	1	725
Type of facility[16]:						
SCHOOL	0.00	0.30	-	0	1	725
OFFICE	1.00	0.53	-	0	1	725
CHILDCARE	0.00	0.26	-	0	1	725
WORKSHOP	0.00	0.03	-	0	1	725
CORRECTIONS	0.00	0.02	-	0	1	725

Summary statistics of additional contract characteristics included in the vector *Z* are listed in Table 2. For instance, the facility to be cleaned and additional services such as periodic floor cleaning (*FLOOR*) and window cleaning (*WIN*) may affect the level of GPP stringency and likelihood of entry because they are associated with investments in special equipment and detergents. Other variables that in principle could affect the assignment of GPP stringency and entry are the number of square meters to be cleaned *(#SQMC*) and the number of contracts in the procurement (*#CONTR)*. Likewise, contracts spanning over several municipalities (*#SITES*) may be of concern for the potential supplier's entry decision or when formulating GPP stringency. The supplier selection method (*MEAT*) is an indicator variable equal to 1 if attributes other than price are considered in the award, which may influence GPP stringency and provide potential suppliers of high-quality and high-cost services with

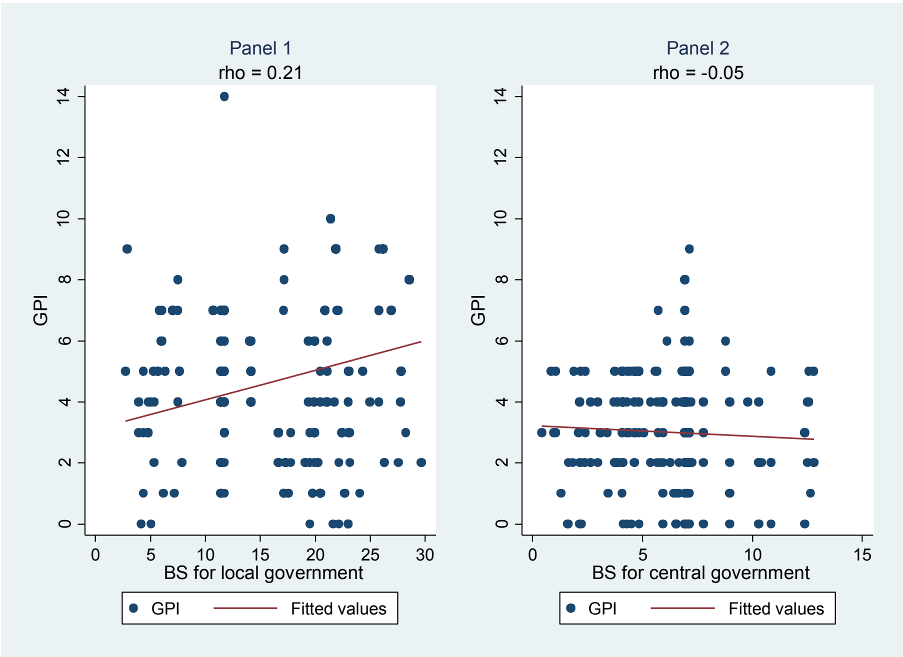
[16] Note that one contract can include several different premises to be cleaned.

incentives to enter the auction. Finally, the assignment of *GPI* and the potential supplier's entry decision might not be invariant to the type of facility to be cleaned, such as *SCHOOL*, *CHILDCARE*, and other facility types. As indicated by the reported medians in Table 1 and 2, *WAGE, #SQMC,* and *#CONTR* appear to be skewed to the right, and in the empirical analysis these are handled by using a log transformation.

4.4 Assignment of GPP stringency

A potential concern for the empirical analysis of buyer market share and supplier incentives is the influence of buyer market share mediated through GPP stringency. Figure 2 illustrates the bivariate correlation between buyer market share and GPP stringency. Based on governance, a crude division of public authorities in Sweden is the nationally elected central government (*GOV*) and locally elected councils such as municipalities, county councils, and public enterprises.[17] Panel 1 in Figure 2 includes observations for local government, whereas Panel 2 restricts attention to observations for central government.

Figure 2. Bivariate correlation between buyer market share (BS) in percent and GPP stringency (GPI) in number of GPP criteria.



A fitted line in Panel 1, including contracts organized by 80 unique locally elected councils, indicates a positive association between buyer market share and GPP stringency. This gives tentative support for locally administrated contracting authorities taking buyer market share into account when implementing GPP. However, there is no such tendency in Panel 2, which includes contracts organized by 96 unique centrally administrated contracting authorities. Together these buyers

[17] *PE* is included in the latter category because the typical public enterprise in the data is a real estate company, bus company, or district heating facility owned by the municipality or county council.

represent 300 out of 725 contracts in the data, for which the correlation is zero. Thus there are indications of central government being less prone to addressing region-specific buyer shares compared with local government. This emphasizes the importance of controlling for authority type in the empirical analysis of GPP stringency and entry.

4.5 Degree of demand coordination when implementing GPP

The coefficient of variation has been used in the literature to measure relative dispersion in prices across markets (see, e.g., Sorensen, 2000). In the current study, this measure is used to assess the degree of demand coordination when implementing GPP. Specifically, the relative dispersion of GPP stringency, $\hat{c} = \frac{s_{GPI}}{G\bar{P}I}$, is defined as the standard deviation of *GPI* in the sample across contracts in a given LMA standardized by its mean. Table 3 presents summary statistics for the 47 (out of 57) LMAs with more than one contract observed during the two-year sample period. The variable $\hat{c}$ is symmetrically distributed around its mean of 0.50, meaning that the average relative dispersion in GPP stringency across contracts is 50%. The variable also indicates considerable heterogeneity across LMAs considering the range of 0% to 100%, in which 0% is equivalent to perfectly coordinated implementation of GPP.

Table 3. Summary statistics of 47 LMAs.

Variable	Median	Mean	Std. dev.	Min.	Max.	#
Average *GPI* ($G\bar{P}I$)	3.14	3.46	1.46	1.3	8.3	47
Absolute dispersion in *GPI*, standard deviation (s_{GPI})	1.68	1.61	0.75	0.0	3.2	47
Relative dispersion in GPP stringency, coefficient of variation ($\hat{c}$)	0.50	0.50	0.24	0.0	1.0	47
Herfindahl index of buyer concentration (*HHI*)	0.68	0.71	0.23	0.3	1.0	47
Number of distinct buyers (Q)						
#MUNI	1.00	1.72	3.80	0.0	19.0	47
#COUNTY	0.00	0.23	0.48	0.0	2.0	47
#GOV	3.00	5.47	9.65	0.0	49.0	47
#PE	0.00	0.36	0.76	0.0	3.0	47

The composition of public buyers in a particular LMA is measured along two dimensions. First, the share of contracts organized by each authority type (*MUNI*, *COUNTY*, *GOV*, *PE)* is used to construct a Herfindahl index (*HHI*) of buyer concentration across authority types. The average buyer concentration is 0.71 and ranges from 0.3 to 1.0. Second, composition within authority types is measured by counting the number of unique buyers per authority type in the LMA (*#MUNI*, *#COUNTY*, *#GOV*, *#PE*). The number of distinct buyers varies across authority types where central government (5.47) and municipality (1.72) have the largest number of distinct buyers per LMA on average. Again, the variables of authority type composition included in the vector *Q* show signs of being skewed to the right, and in the empirical analysis these are transformed by taking natural logarithms.[18] The maximum number of distinct buyers refers to Stockholm LMA, which consists of 25 municipalities and numerous central government authorities.

5. Empirical approach

Three equations are estimated in the empirical analysis. Equation (1) relates buyer characteristics and contract characteristics to the level of GPP stringency. Because the dependent variable is a count variable, a Poisson regression model is fit to the data with the following specification:

$$GPI_{jm} = \beta_0 + \beta_1' W_{jm} + \beta_2' Z_j + \varepsilon_{jm} \quad (1)$$

The dependent variable GPI_{jm} for contract j in LMA m is regressed on a vector of buyer characteristics (W_{jm}) and contract characteristics (Z_j). Included in W_{jm} are buyer market share (BS), indicator variables for authority type, proportion of seats in the relevant council or Parliament held by the Green Party ($REPR$), an indicator variable taking a value of one if the Green Party holds the balance of power ($BPOW$), and the natural log of the average wage ($ln\,(WAGE)$) as specified in Section 4.1. The coefficient related to the variable BS_m is intended to capture the contracting authorities' response to variation in buyer market share. Likewise, the coefficients on the dummy variables for authority type capture systematic differences in the level of GPP stringency. $REPR$ and $BPOW$ serve as controls for voter preferences for environmental questions as related to the Green Party's indirect and direct influence in the policy-making process. The coefficient on $ln(WAGE)$ is intended to capture the region-specific willingness to pay for environmental attributes.[19] The vector Z_j includes contract characteristics that might affect the level of GPP stringency as specified in Section 4.3. Not included in Z_j are the variables *ENVREG* and *QINDEX* or the contractual terms regarding planned follow-ups that the contractors actually deliver according to the green criteria (*EMON*) and quality criteria (*QMON*). Finally, the β terms are the parameter vectors to be estimated and ε_{jm} represents the unobserved factors that affect the level of GPP stringency.

Equation (2) relates cross-sectional variation in buyer composition across LMAs to the degree of demand coordination (or equivalently, the degree of standardization) when implementing GPP. The following model is estimated by ordinary least squares (OLS):

$$\hat{c}_m = \alpha_0 + \alpha_1 HHI_m + \alpha_2' Q_m + \varepsilon_m \quad (2)$$

The dependent variable $\hat{c}_m$ is the relative dispersion in GPP stringency across contracts in LMA m. This variable takes a value of zero if there is no dispersion in GPP stringency in the LMA, and this is

[18] Log$(x + 1)$ is used to avoid taking the log of zero.

[19] See Stern (2004) and Hökby and Söderqvist (2003) for a theoretical discussion and an empirical application, respectively, on the environmental Kuznets curve, which describes the relationship between income per capita and willingness to pay for environmental attributes.

consistent with perfectly coordinated implementation of GPP. The coefficient on the HHI_m variable captures the effect of buyer concentration on the relative dispersion. Based on the discussion in Section 3.1 of the importance of homogeneous buyer preferences for successful demand coordination, a negative significant effect on $\hat{c}_m$ could be taken to indicate support for preferences being authority-type specific. To control for potential heterogeneities within authority types, the vector Q_m includes variables for the number of distinct buyers per authority type in the LMA observed during the sample period. Lastly, the α coeficients are parameters to be estimated, and ε_m represents unobserved factors affecting the relative dispersion in GPP stringency.

The third research question concerns the potential supplier's response to variation in buyer market share that is conditional on covariates. The expected profitability of a contract, net of entry costs, compliance costs, and opportunity costs are not directly observed in the data. However, as described in Section 3.2, the incentive structure of GPP can be inferred from the observed entry decisions of the potential suppliers. That is, a potential supplier will submit a bid when the latent expected net profit of the contract is non-negative (e.g. Samuelson, 1985; Levin and Smith, 1994; Li and Zheng, 2009; Krasnokutskaya and Seim, 2011; Lundberg et al., 2015). Approximating the set of potential suppliers according to the market definition in Section 4.1, the probability of submitting a bid is estimated as a logit model with the following specification:

$$\Pr\left(ENTRY_{ijm} = 1\right) = \gamma' W_{jm} + \omega' Z_j + \tau' X_{ij} + \varphi N_m + \delta N_m^2 + \kappa_i + u_{ijm} \qquad (3)$$

where the binary variable $ENTRY_{ijm}$ takes a value of one if potential supplier i submits a bid for contract j in LMA m and zero otherwise. Included in the vector W_{jm} of buyer characteristics are BS and other covariates as specified in Section 4.1. Based on the discussion in Section 3.2, a potential supplier's incentive to enter a bid for a public contract is expected to increase in the relevant buyer market share. The hypothesis is tested by inspecting the estimated coefficient on BS; a positive significant relationship can reject the null hypothesis of no effect from BS.

The vector Z_j includes GPI_{jm} and other contract characteristics defined in Section 4.3 that may influence the expected net profitability of a contract. To control for supplier heterogeneity, the vector X_{ij} includes the full set of observed supplier-specific characteristics defined in Section 4.2. The number of potential suppliers (N_m) is a determinant for the competitive bidding environment in the LMA, and the quadratic functional form is included to capture the potentially non-monotone decreasing relationship between the equilibrium bid and N_m (Li and Zheng, 2009).

Supplier fixed effects (κ_i) are included to account for unobserved supplier heterogeneity such as differences in production technologies and processes (Jofre-Bonet and Pesendorfer, 2003), and u_{ijm}

captures the unobserved factors that affect the expected net profitability of potential supplier i on contract j in LMA m.

The estimated coefficient on BS captures the direct effect of buyer market share on the expected net profitability of the contract. A natural question is the extent to which the control variable, *GPI*, explains the relationship between buyer market share and the probability of submitting a bid. Therefore, the analysis is extended by decomposing the total effect of BS on entry into a direct effect and an indirect effect that is mediated by the control variable *GPI*. This decomposition is performed by comparing the estimated coefficients of two nested logit models following the KHB method discussed in Kohler et al. (2011), Karlson et al. (2012), and Breen et al. (2013).

6. Results

6.1 GPP stringency and demand coordination of GPP

Based on Equation (1), Table 4 reports the estimated coefficients from three Poisson regression models of the level of GPP stringency (GPI_{jm}) on buyer characteristics and contract characteristics. For a full presentation of the results, see Table A3 in the Appendix. Model 1 is a parsimonious specification with BS as the sole buyer characteristic variable. Model 2 is extended by including the vector W_{jm} of buyer characteristics. Model 3 is the full specification that also includes the vector Z_j of contract characteristics. There is a positive significant relationship between BS and GPI_{jm} throughout Model 1 and Model 3. Based on Model 3, GPI_{jm} is predicted to increase from 3.2 to 5.0 criteria when evaluated at the 25th percentile (6.9%) and the 75th percentile (19.5%) of BS, which is a significant difference of 1.8 GPP criteria.[20]

The results further indicate heterogeneity in GPI_{jm} across authority types. Based on Model 3, county councils and the central government both specify significantly more GPP criteria in the call for tender relative to the reference category of municipalities ($p < 0.01$ and $p < 0.05$, respectively). Interestingly, whereas the estimated coefficient for the proportion of seats in the council held by the Green Party ($REPR$) is insignificant, the Green Party holding the balance of power ($BPOW$) is associated with a significant increase in GPI_{jm} ($p < 0.01$). This suggests that the stringency of environmental concerns in public procurement is influenced by the political coalition currently in power. Lastly, the logarithm of the average wage level in the LMA is positive but not statistically significant at conventional levels.

[20] A Wald test rejects the null of equality (p-value = 0.015).

Table 4. Count regressions with contract-level GPI on buyer characteristics and contract characteristics.

Variable	Model 1 Negative Binomial *GPI*	Model 2 Negative Binomial *GPI*	Model 3 Poisson *GPI*
	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)
BS	0.029^{***}	0.037^{**}	0.035^{**}
	(0.010)	(0.015)	(0.014)
COUNTY	-	0.784^{***}	0.923^{***}
		(0.194)	(0.214)
GOV	-	0.113	0.373^{**}
		(0.150)	(0.173)
PE	-	0.107	0.406
		(0.304)	(0.273)
REPR	-	0.044	0.042
		(0.029)	(0.026)
BPOW	-	0.525^{***}	0.372^{***}
		(0.137)	(0.134)
ln(WAGE)	-	0.452	0.333
		(0.422)	(0.383)
Contract characteristics	NO	NO	YES
Observations	725	725	725
Pseudo R^2	0.025	0.070	0.134

Notes. Standard errors (in parenthesis) are robust and account for 339 clusters at the procurement level. COUNTY indicates county council, GOV indicates central government, and PE indicates public enterprises. MUNICIP is the omitted reference category. Models 1 and 2 were estimated by a negative binomial model because a Poisson model showed signs of overdispersion. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Models 1 through 3 do not allow the effect of *BS* to vary across authority types. However, Figure 2 in Section 4.4 indicates differences in the assignment rule for local government and central government. A natural extension of the discussion is to extend the analysis by estimating local governments and central government separately. Results for Model 4 and 5 are given in Table 5. For the subsample of local government in Model 4, the estimated coefficient on buyer market share is positive at the 1% significance level. The corresponding coefficient for the subsample of central government in Model 5 is statistically insignificant and gives further support for central government being less prone to addressing region-specific buyer market share. Note that the dummy variables in Model 5 for authority type and political representation in the council are invariant across observations and hence cannot be estimated.

Table 5. Count regressions with contract-level GPI for the subsamples of local and central government.

Variable	Model 4 Local government Poisson *GPI*	Model 5 Central government Poisson *GPI*
	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)
BS	0.054^{***}	-0.010
	(0.020)	(0.013)
COUNTY	1.116^{***}	-
	(0.279)	
GOV	-	-
PE	0.585^{*}	-
	(0.327)	
REPR	0.057^{**}	-
	(0.026)	
BPOW	0.349^{**}	-
	(0.151)	
ln(WAGE)	0.836	0.468
Contract characteristics	YES	YES
Observations	425	300
Pseudo R^2	0.147	0.056

Notes. Standard errors (in parenthesis) are robust and clustered at the procurement level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results from an OLS regression of the relative dispersion in GPP stringency ($\hat{c}_m$) on buyer composition from Equation 2 are presented in Table 6. Model 1 includes a single covariate of buyer concentration across authority types, defined as the variable *HHI*. Model 2 is extended by including controls for the number of distinct buyers within each authority type. The estimated coefficient on *HHI* in Models 1 and 2 indicates a negative significant effect on $\hat{c}_m$ (p < 0.01). Hence, LMAs with high concentrations of public buyers in terms of the sum of the squared contract shares of municipalities, county councils, governmental authorities, and public enterprises are associated with more coordinated implementation of GPP and this is consistent with preferences being heterogeneous across authority types. It is worth noting that the estimated coefficients on the number of distinct buyers of each authority type are statistically insignificant at conventional levels indicating a low degree of buyer heterogeneity within authority types.

Table 6. OLS with relative dispersion in GPP stringency ($\hat{c}$) on buyer composition.

Variable	Model 1 $\hat{c}$	Model 2 $\hat{c}$
	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)
HHI	-0.43^{***}	-0.52^{***}
	(0.14)	(0.18)
ln(#*MUNI* + 1)	-	-0.10
		(0.06)
ln(#*COUNTY* + 1)	-	-0.19
		(0.13)
ln(#*GOV* + 1)	-	0.09
		(0.05)
ln(#*PE* + 1)	-	0.07
		(0.11)
Constant	0.81^{***}	0.83^{***}
	(0.10)	(0.16)
Observations	47	47
Adjusted R^2	0.157	0.187

Notes. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A conclusion that can be made at this point is that demand coordination, as measured by relative dispersion in GPP stringency, is higher for LMAs with high buyer concentration. Stringency of the purchasing policy is not invariant to the political coalition currently in power in the respective council. In addition, there are systematic differences across authority types when implementing GPP, both in the level of GPP stringency and in their response to varying buyer market share. More specifically, local administrations seem to acknowledge their buyer market share when stipulating GPP stringency, which is in contrast to the central government. This variation in assignment rule that is conditional on authority type is useful when studying the effect of buyer market share on supplier incentives in the empirical analysis of entry into procurement auctions.

6.2 Supplier response to buyer market share

Estimates for three supplier fixed effects logit models on entry from Equation 3 are presented in Table 7 (see Table A4 in the Appendix for the full list of covariates). In contrast to Model 2, Model 1 does not include the variables on voter preferences and average wage level (*REPR*, *BPOW*, and *ln(WAGE)*). In addition, Model 3 includes potential supplier fixed effects. Standard errors are robust and are clustered at the procurement level to account for potential correlation across contracts in the same procurement. Potential suppliers generally match on contract size (#*SQMC*) and location (*HEADQ*). Specifically, large contracts are associated with increased participation ($p < 0.05$) and suppliers with headquarters located within the same LMA as the delivery site are more likely to enter a bid ($p < 0.01$). Furthermore, the number of potential suppliers N has a non-linear effect on the latent expected net profitability of the contract, and this is in line with theoretical predictions by Li and Zheng (2009).

Table 7. Logit regression of supplier-level entry on buyer market share and other covariates.

Variable	Model 1 *ENTRY*	Model 2 *ENTRY*	Model 3 *ENTRY*
	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)
BS	0.021	0.037**	0.039**
	(0.015)	(0.017)	(0.018)
GPI	−0.021	−0.037**	−0.049**
	(0.018)	(0.018)	(0.022)
ENVREG	−0.033	−0.036	−0.049
	(0.048)	(0.049)	(0.057)
EMON	0.254*	0.252	0.331**
	(0.146)	(0.154)	(0.167)
ln(#SQMC)	0.081***	0.056**	0.076**
	(0.025)	(0.026)	(0.030)
SIZE	0.180***	0.181***	0.220*
	(0.012)	(0.012)	(0.115)
HEADQ	0.742***	0.730***	1.215***
	(0.132)	(0.132)	(0.115)
N	−0.046***	−0.051***	−0.042***
	(0.005)	(0.006)	(0.007)
N^2	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Additional buyer characteristics	NO	YES	YES
Additional contract characteristics	YES	YES	YES
Potential supplier fixed effects	NO	NO	YES
Observations	31,139	31,139	30,195
Pseudo R^2	0.197	0.199	0.323

Notes. Standard errors (in parenthesis) are robust and account for 339 clusters at the procurement level. The discrepancy in the number of observations in Model 2 arises because nine potential suppliers never entered a bid and could not be estimated.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

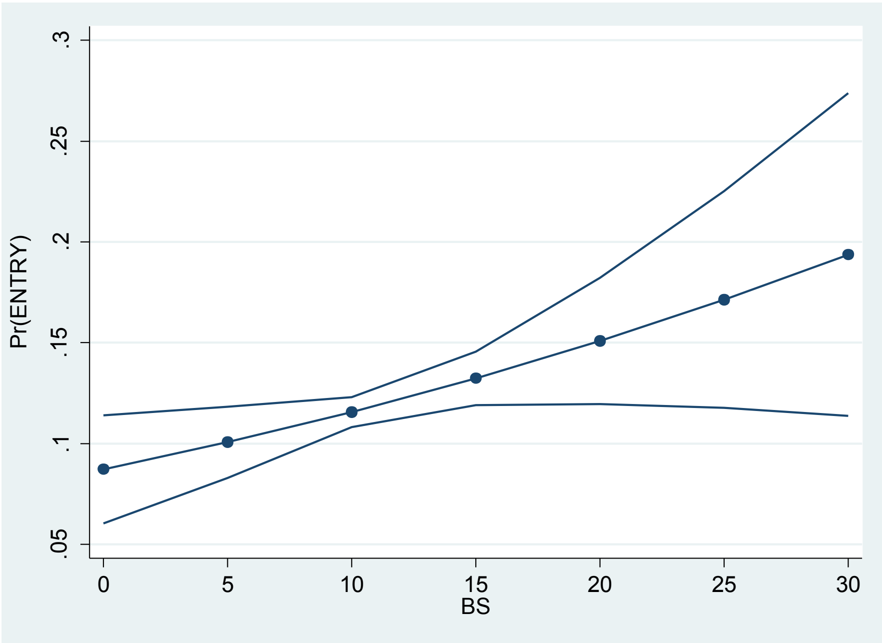
Of primary interest for the analysis of buyer power in the context of GPP is the effect of buyer market share on potential supplier's incentives to bid for the contract, all else being equal. The estimated coefficient on *BS* indicates a positive significant effect on entry in Model 2 ($p < 0.05$), and the effect is robust to the inclusion of supplier fixed effects in Model 3. The coefficients on *BS* and *GPI*, however, become insignificant when excluding the variables on voter preferences and average wage level as indicated by Model 1. A plausible explanation for these results is that the initial environmental performance of the potential suppliers is higher in regions where the voters have stronger support for environmental issues. Not controlling for voter preferences in the analysis of potential supplier incentives would, in such instances, result in omitted variable bias.

Figure 3 illustrates the predicted probability of entry as a function of *BS* based on Model 2.[21] The function is monotonically increasing with *BS*, although the effect becomes imprecise for values of *BS* above 15%. In particular, the probability of entry is predicted to increase from 0.106 to 0.121 when

[21] Predictions based on Model 3 produce identical results.

evaluated at the 25th percentile (6.9%) and the 75th percentile (11.8%) of *BS*, with a significant difference of 0.015.[22] The direct effect of *BS* thus supports arguments that increased buyer market share is able to incentivize the potential suppliers to undertake a costly investment; in this case undertaking expensive bid preparation costs, including possible compliance costs, and submitting a bid.

Figure 3. Predicted probabilities of ENTRY with 95% confidence intervals (solid curved lines) at specified values of BS.



The estimated coefficient for the policy variable *GPI* gives a somewhat mixed result. The point estimate is statistically insignificant and negative in Model 1, and this is in line with the general result in Lundberg et al. (2015). However, when conditioning on the additional buyer characteristics of voter preferences and the average wage level in Models 2 and 3, the effect becomes negative and significant ($p < 0.05$). Based on Model 2, the probability of entry is predicted to decrease from 0.128 to 0.118 when evaluated at the 25th percentile (2 GPP criteria) and the 75th percentile (5 GPP criteria) of *GPI*, which is a significant difference of −0.01.[23] By comparing otherwise similar contracts, the results suggest that an increased number of GPP criteria lowers the incentives to bid for the contract as indicated by a reduced probability of submitting a bid. As a comparison, the effect associated with public regulation (*ENVREG)* is insignificant. Thus an increased number of green criteria referring to public regulations does not appear to affect the potential supplier's entry behavior, and this is as expected.

[22] A Wald test can reject the null of equality (p-value = 0.025).
[23] A Wald test can reject the null of equality (p-value = 0.051).

Based on Model 2, the total effect of *BS* is decomposed into a direct effect and an indirect effect by comparing the estimated coefficients of two nested logit models (Kohler et al., 2011; Karlson et al., 2012; Breen et al., 2013). Results of this decomposition are presented in Table 8. The reduced model is estimated by using the estimated residuals of a linear regression of *GPI* on *BS* instead of *GPI*.[24] The estimated coefficient on *BS* in the reduced model can then be interpreted as the total effect of buyer market share on entry. The indirect effect of *BS* mediated by *GPI* is obtained by taking the difference between the estimated coefficients of the reduced model and the full model. The indirect effect is negative but statistically insignificant. Hence, the indirect effect of *GPI* on *BS* is limited, and the difference in the coefficients amounts to about 9%.

Table 8. Decomposition of the effect of buyer market share on probability of entry.

Variable	Model 2 *ENTRY*
	$\hat{\beta}$ (s.e.)
BS	
Reduced model, total effect	0.034**
	(0.017)
Full model, direct effect	0.037**
	(0.017)
Difference, indirect effect	−0.003
	(0.003)

Notes. Standard errors (in parenthesis) are robust and account for 339 clusters at the procurement level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7. Discussion and conclusions

Advocates of GPP argue that the public sector should use its buyer power to steer industries into becoming less environmentally damaging. In this paper, implementation of GPP was found to be highly dispersed across authority types with regard to both the level of GPP stringency and the contracting authority's response to variation in buyer market share. Type-specific implementation of GPP suggests that various public authorities are more inclined to opt for a flexible implementation according to idiosyncratic preferences rather than using the public sector's full potential buyer power by coordinating its actions. Uncoordinated implementation of GPP makes it possible for potential suppliers to substitute public and private contracts with less stringent GPP criteria. This may weaken the ambition set out by policy makers of providing the potential suppliers with real incentives to comply with the GPP criteria.

Previous literature on individual GPP criteria has indicated generally small effects on the potential supplier's probability of submitting a bid (Lundberg et al., 2015). The index of GPP stringency used in this paper suggests that the total number of GPP criteria specified in the call for tender may be of greater concern for the potential suppliers, as indicated by the reduced probability of submitting a bid.

[24] The correlation between *BS* and *GPI* is 0.2.

In addition, the analysis adds to previous literature on endogenous entry into auctions by assessing the effect of buyer market share on the probability of potential suppliers submitting a bid. Buyer market share, as measured by the share of the workforce in the region being employed by the authority type, is shown to increase the probability of a potential supplier submitting a bid. This result thus supports the arguments that buyer market share is an important determinant for the ability of the purchasing policy to contribute to reduced emissions. The initiative by the European Union to adopt a common set of green standards such as “eco-labels” should be evaluated in light of these findings. A European Union-wide adoption of green criteria would facilitate increased buyer power through coordinated implementation of GPP. Increased buyer power through coordinated implementation may, however, come at the cost of reduced flexibility in accommodating heterogeneous buyer preferences, including valuation of region-specific externalities in production and the regional market structure.

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Appendix

Table A1. Frequency table of firm size according to SCB's definition.

Class size (*SIZE*)	Number of employees	Frequency
1.	0	31
2.	1–4	54
3.	5–9	30
4.	10–19	34
5.	20–49	52
6.	50–99	35
7.	100–199	24
8.	200–499	18
9.	500–999	4
10.	1,000–1,499	3
11.	1,500–1,999	0
12.	2,000–2,999	2
13.	3,000–3,999	3
14.	4,000–4,999	1
15.	5,000–9,999	8
16.	10,000–	2
Observations		301

Table A2. Total number of criteria for all 725 contracts

Green criteria	%	#	Quality criteria	%	#
GPP-criteria			Insurance	43	725
Environmentally friendly cleaning products	72	725	Limited liability insurance	88	725
Routines for bookkeeping of chemicals	41	725	Credit rating	74	725
Provision of list of intended use of chemicals	22	725	Affidavit	54	725
Continuously updated list of chemicals	6	725	Documentation from the Tax Authority	61	725
Green criteria, vehicles	13	725	Annual report	38	725
Green criteria, fuel	9	725	Information on turnover	20	725
Eco driving	8	725	The firm has to provide a bank deposit	1	725
Plan for decreasing need for fossil fuel	2	725	Experience required	88	725
Allergy-friendly cleaning products	37	725	Provision of list of all earlier jobs	3	725
Non-allergenic substances as defined by IFRA-norm	12	725	References required	85	725
Firm required to have an environmental management system	68	725	Original references required	10	725
Firm required to have a documented environmental management system	58	725	Foreman needs a cleaning certificate	49	725
Firm required to have an environmental certificate	27	725	Foreman needs equivalent of a cleaning certificate	12	725
ISO standard 14000	10	725	Foreman's CV needs to be provided	39	725
ISO standard 14001	16	725	Swedish-speaking employees	70	725
ISO standard 14024	0.3	725	Criminal records must be provided	30	725
ISO standard 14025	0.6	725	The firm must be connected to a union	7	725
Public regulation			Firm must act as equivalent to union terms	36	715
Swedish Chemicals Agency Code of Statutes 2005	15	725	Plan of how to structure work	76	725
Code of Statutes of the Swedish Chemicals Agency 2008[25]	9	725	Firm needs a quality plan	84	725
Code of Statutes of the Swedish Chemicals Agency 1994[26]	1	725	Firm needs a certified quality plan	34	725
REACH	2	725	Insta 800	21	725
The Swedish Environmental Code	19	725	SIS	27	725
Swedish Work Environment Authority Chemicals	2	725	ISO standard 9000	16	725
Swedish Chemicals Agency O-list	3	725	*Contractual terms*		
Swedish Chemicals Agency B-list	19	725	Planned quality revision	88	725
Swedish Environmental Management Council (MSR)	26	725			
EU euro4 classification of vehicles	7	725			
Contractual terms					
Planned environmental revision	9	725			

[25] The Swedish Chemicals Agency's Chemical Products and Biotechnical Organisms Regulations (KIFS 2008:2)
[26] Older version of KIFS 2008:2.

Table A3. Count regressions with contract-level GPI on buyer characteristics and contract characteristics.

Variable	Model 1 Negative Binomial *GPI*	Model 2 Negative Binomial *GPI*	Model 3 Poisson *GPI*	Model 4 Poisson Subsample of local government *GPI*	Model 5 Poisson Subsample of central government *GPI*
	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)
BS	0.029***	0.037**	0.035**	0.054***	-0.010
	(0.010)	(0.015)	(0.014)	(0.020)	(0.013)
COUNTY	-	0.784***	0.923***	1.116***	-
		(0.194)	(0.214)	(0.279)	
GOV	-	0.113	0.373**	-	-
		(0.150)	(0.173)		
PE	-	0.107	0.406	0.585*	-
		(0.304)	(0.273)	(0.327)	
REPR	-	0.044	0.042	0.057**	-
		(0.029)	(0.026)	(0.026)	
BPOW	-	0.525***	0.372***	0.349**	-
		(0.137)	(0.134)	(0.151)	
ln(WAGE)	-	0.452	0.333	0.836	0.468
		(0.422)	(0.383)	(0.723)	(0.366)
FLOOR	-	-	0.008	−0.094	0.027
			(0.097)	(0.123)	(0.133)
WIN	-	-	0.258***	0.306**	0.252**
			(0.095)	(0.124)	(0.118)
ln(#SQMC)	-	-	0.000	−0.001	−0.005
			(0.024)	(0.027)	(0.035)
ln(#CONTR)	-	-	0.050	0.067	0.028
			(0.030)	(0.043)	(0.041)
#SITES	-	-	−0.110*	0.046	−0.098
			(0.062)	(0.100)	(0.064)
MEAT	-	-	0.069	-0.132	0.338***
			(0.099)	(0.121)	(0.097)
SCHOOL	-	-	0.219***	0.154**	0.361*
			(0.080)	(0.075)	(0.212)
OFFICE	-	-	−0.165**	-0.199**	0.093
			(0.084)	(0.088)	(0.249)
CHILDCARE	-	-	−0.023	-0.019	−0.019
			(0.088)	(0.088)	(0.290)
WORKSHOP	-	-	0.093	0.063	−1.091***
			(0.178)	(0.171)	(0.095)
CORRECTIONS	-	-	−0.741***	-	-0.394*
			(0.256)		(0.230)
Constant	0.999***	−1.977	−1.501	−4.637	−1.671
	(0.099)	(2.431)	(2.167)	(4.201)	(1.935)
Observations	725	725	725	425	300
Pseudo R^2	0.025	0.070	0.134	0.147	0.056

Notes. Standard errors (in parenthesis) are robust and account for 339 clusters at the procurement level. COUNTY indicates county council, GOV indicates governmental authority, and PE indicates public enterprises. MUNICIP is the omitted reference category. Models 1 and 2 were estimated by a negative binomial model because a Poisson model showed signs of overdispersion. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4. Logit regression of entry on buyer market share and other covariates.

Variable	Model 1 *ENTRY*	Model 2 *ENTRY*	Model 3 *ENTRY*
		$\hat{\beta}$ (s.e.)	$\hat{\beta}$ (s.e.)
BS	0.021	0.037**	0.039**
	(0.015)	(0.017)	(0.018)
GPI	−0.021	−0.037**	−0.049**
	(0.018)	(0.018)	(0.022)
ENVREG	−0.033	−0.036	−0.049
	(0.048)	(0.049)	(0.057)
EMON	0.254*	0.252	0.331**
	(0.146)	(0.154)	(0.167)
QINDEX	−0.005	−0.002	−0.008
	(0.016)	(0.016)	(0.018)
QMON	0.054	0.021	0.006
	(0.136)	(0.131)	(0.148)
FLOOR	0.069	0.050	0.012
	(0.106)	(0.101)	(0.112)
WIN	−0.307***	−0.326***	−0.341***
	(0.090)	(0.086)	(0.100)
ln(#SQMC)	0.081***	0.056**	0.076**
	(0.025)	(0.026)	(0.030)
ln(#CONTR)	0.018	0.005	−0.025
	(0.044)	(0.040)	(0.040)
#SITES	−0.178**	−0.144**	−0.156*
	(0.073)	(0.072)	(0.080)
MEAT	−0.029	−0.028	−0.080
	(0.090)	(0.090)	(0.099)
SCHOOL	−0.110	−0.068	−0.063
	(0.078)	(0.080)	(0.094)
OFFICE	−0.052	−0.047	−0.038
	(0.089)	(0.088)	(0.093)
CHILDCARE	−0.099	−0.096	−0.176**
	(0.068)	(0.062)	(0.073)
WORKSHOP	−0.614***	−0.588**	−0.618**
	(0.236)	(0.237)	(0.241)
CORRECTIONS	−0.433**	−0.478***	−0.582***
	(0.182)	(0.175)	(0.195)
COUNTY	−0.110	0.221	0.248
	(0.276)	(0.289)	(0.339)
GOV	0.199	0.366**	0.357**
	(0.154)	(0.153)	(0.172)
PE	0.386*	0.530**	0.637***
	(0.210)	(0.220)	(0.240)
REPR	−	0.068***	0.051*
		(0.023)	(0.027)
BPOW	−	0.126	0.104
		(0.127)	(0.149)
ln(WAGE)	−	0.540	−1.694
		(1.733)	(1.858)
SIZE	0.180***	0.181***	0.220*
	(0.012)	(0.012)	(0.115)
LTD	1.762***	1.771***	1.831
	(0.237)	(0.238)	(1.370)
HEADQ	0.742***	0.730***	1.215***
	(0.132)	(0.132)	(0.115)
#POTBIDS	−0.046***	−0.051***	−0.042***
	(0.005)	(0.006)	(0.007)
#POTBIDS^2	0.000***	0.000***	0.000***

	(0.000)	(0.000)	(0.000)
Constant	-3.808^{***}	-7.085	4.634
	(0.503)	(9.486)	(10.235)
Potential supplier fixed effects	NO	NO	YES
Observations	31,139	31,139	30,195
Pseudo R^2	0.197	0.199	0.323

Notes. Standard errors (in parenthesis) are robust and account for 339 clusters at the procurement level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.