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October 2026

Working paper No. 2026–12

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Environmental Criteria and Clauses in Public Procurement: Theory and Evidence on Their Effects on Bidder Participation

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Abstract

Many governments around the world use public procurement as an environmental policy instrument through clauses (i.e., mandatory environmental requirements governing contract performance) and award criteria (i.e., the dimensions used to evaluate bids). Green clauses and criteria are often thought to discourage firm participation in procurement procedures by excluding firms and raising participation costs. This article assesses the impact of green clauses and criteria on firm participation from both theoretical and empirical perspectives. From a theoretical standpoint, we show that these instruments have a twofold effect: although they can exclude some firms and raise participation costs, they also increase firms' expected margins. We empirically illustrate this prediction using 50,000 procurement procedures in France between 2022 and 2023. We find a positive association between the implementation of green clauses and criteria and firm participation in procurement procedures, despite evidence of heterogeneity across procurement sectors and public buyers. The results of this paper suggest that the growing integration of sustainability into public procurement is unlikely to explain the observed decline in participation in procurement procedures.

Keywords:

Green Public Procurement, Auctions, Competition, Participation

JEL: D44; D86; H57; Q01; Q58

1. Introduction

Competition in public procurement is a key concern for governments. Indeed, low competition can result in higher prices, lower quality, and increased corruption, thereby degrading public services. The erosion of effective competition in public procurement procedures in Europe has recently come to the fore in Special Report 28/2023 of the European Court of Auditors (European Court of Auditors, 2023). This report echoes similar findings in the United States (Kang and Miller, 2022).

Lower firm participation is usually seen as the main driver of the weakening of competition. Identifying the underlying causes of the observed decline in firm participation in procurement procedures is crucial. It may be driven by more pervasive corruption (Fazekas et al., 2016) or by increased procedural complexity stemming from multiple public policy objectives. Indeed, contracting authorities often pursue multiple objectives, while ensuring the efficient use of public funds. In particular, public procurement must be aligned with sustainable development practices, with environmental considerations playing a central role. Green public procurement is implemented through green clauses—i.e., environmental requirements governing contract performance for selected suppliers—and green award criteria, whereby contracting authorities partly base bid scoring on environmental quality.

The implementation of green clauses and criteria is probably not neutral with respect to firm participation. Indeed, they can increase participation costs and tend to favor firms with stronger environmental capabilities. Most empirical studies find moderate negative effects of green clauses and criteria on participation, including Vigren (2018) for bus contracts in Sweden and Carreras (2023) for Spanish public procurement. In France, Arve and Desrieux (2026) find a negative effect of green award criteria in the context of municipal procurement. Other studies report mixed and limited effects of green clauses and criteria on firm participation. For instance, based on a sample of 337 auctions for cleaning service contracts in Sweden, Lundberg et al. (2015b) and Drake et al. (2024) do not find a clear effect of green clauses on participation. By contrast, when focusing on SME participation, Deschamps (2025) finds that green clauses and criteria do not appear to reduce the probability that at least one SME participates in a procurement procedure.

In this paper, we reexamine the links between firm participation in procurement procedures and the implementation of green clauses and criteria

for two reasons.

First, existing studies on firm participation in green public procurement do not rest on a dedicated theoretical model. In this paper, within an original theoretical framework with endogenous quality, we show that although some firms may choose not to participate due to green requirements and higher participation costs, green clauses and criteria can also stimulate participation through higher expected margins. The impact of green clauses and criteria on firm participation therefore depends on the relative magnitude of these opposing effects. This theoretical prediction qualifies the results of the existing empirical literature by showing that the effect of green procurement on participation could be more ambivalent than expected.

Second, we illustrate our theoretical model using data similar to those used by Deschamps (2025). Our paper extends this study by examining the total number of bidders rather than the probability that at least one SME participates. Compared with the data used in other empirical studies on firm participation in green public procurement, our data are more recent, larger, and more comprehensive, as they include both green clauses and green award criteria. We analyze 50,000 procurement procedures in France between 2022 and 2023. In contrast to previous studies focusing on specific sectors or contracting authorities, we find robust evidence of an overall positive association between green clauses and criteria and firm participation. However, we also find evidence of sectoral heterogeneity in this relation.

The remainder of the paper is structured as follows. Section 2 provides an overview of the institutional background of French public procurement. Section 3 presents a theoretical framework analyzing participation with multidimensional bids and endogenous quality. Section 4 describes the data used to illustrate the theoretical model. Section 5 outlines the econometric strategy. Section 6 presents the empirical results, and Section 7 provides robustness checks. Section 8 discusses the policy implications of this paper.

2. Institutional background

Public procurement procedures. Under European Union law, public procurement procedures in France are governed by the fundamental principles of freedom of access, equal treatment of candidates, and transparency of procedures. The BOAMP (“Bulletin Officiel des Annonces des Marchés Publics”) is the official journal in which public buyers publish calls for tenders and award notices. Usually, contracts are divided into lots to facilitate participation by

small firms and increase competition, as contracts may involve heterogeneous tasks. After a specified advertising period, contracting authorities select one or more bidders, based on the award criteria specified in the call for tenders. The outcome of the procedure is then published in an award notice.

Green clauses and criteria. Green procurement practices are gaining momentum in France. Following the 2021 “Climat et Résilience” law, all procurement contracts are required to consider environmental issues by integrating at least one green clause *and* one green award criterion as of August 2026.

Green clauses refer to mandatory environmental specifications that govern the performance of the contract by the selected suppliers. For example, in the procurement of vehicles, contracting authorities may require the supplier to provide electric vehicles. In contrast, green award criteria partly base bid evaluation on environmental characteristics. For instance, 20% of the score assigned to each bid may depend on the carbon emissions of the vehicles. In this case, offering electric vehicles is not mandatory but may be rewarded in the scoring if these vehicles have a lower carbon footprint. Therefore, green clauses impose a minimum level of environmental quality that bids must meet, while green award criteria reward the environmental characteristics of the bid through a trade-off between price and quality. Green clauses are a constraining instrument, while green criteria are incentivizing ones. Importantly, to be legal, green clauses and criteria must be specifically related to the subject matter of the contract. They cannot discriminate against bidders on the basis of general characteristics such as certifications or governance rules.

3. Theoretical insights

Related literature. The literature has determined the optimal procedures for awarding procurement contracts when price and quality matter (Che, 1993; Asker and Cantillon, 2010). It has essentially considered frameworks in which, on the one hand, quality is observable and verifiable, and, on the other hand, the buyer is able to describe her preferences in terms of price-quality trade-offs. In this context, comparing the commonly used procedures, Asker and Cantillon (2008) show that scoring auctions dominate price-only auctions with minimum quality thresholds. Che (1993) shows that even a “naive” scoring auction, where the scoring of the quality dimension reveals the buyer’s preferences—although it is not optimal—performs no worse than a price-only auction where quality is fixed.

However, the superiority of scoring auctions is based on assumptions that rarely hold in practice. First, public buyers do not necessarily fully reveal their preferences, as they typically announce the criteria and their weights only. For instance, in France, the fully specified scoring rule—i.e., how the quality measure and the price are transformed into a single score—is often not disclosed. Second, price and quality are not always perfectly substitutable, depending on the nature and technical complexity of public contracts (Estache and Iimi, 2009). As stressed by Bergman and Lundberg (2013), the downside of the flexibility of a scoring auction is that the quality level is not known *ex ante*. Therefore, if it is of critical importance to reach a minimum quality, it is better to use a first-price auction with a minimum quality threshold. Third, the comparison of procedures is carried out under the assumption that the number of participating firms is exogenous. However, a firm’s decision to submit a bid can vary from one procedure to another, depending, for example, on the participation cost and/or the presence of a clause imposing a specific level of quality that only a few firms can provide (Estache and Iimi, 2009).

In order to analyze the impact of endogenous participation on the expected cost of a contract, the literature first considered contracts in which the price is the sole award criterion. Two extreme cases were then studied: one in which bidders have perfect information about their costs before deciding to participate (Samuelson, 1985; Menezes and Monteiro, 2000), and the other in which bidders learn their cost after they have made the decision to participate in the auction (Levin and Smith, 1994). A key result of this literature (Samuelson, 1985) is that—contrary to models with an exogenous number of bidders—expected costs do not necessarily decline when the number of bidders increases. In other words, increasing firm participation does not always benefit the public purchaser. The intuition behind this result is as follows: when firms incur participation costs, fewer firms actually submit a bid; but the firms that remain are the most efficient ones, and, knowing that they face equally efficient rivals, they bid more aggressively than they would in the absence of participation costs. The effect of the reduction in the number of bids may—or may not—be offset by the more aggressive nature of these bids. Policymakers should therefore be cautious in interpreting higher participation in procurement procedures as leading to lower prices.

The literature has also recently analyzed the participation of firms when a procurement contract is awarded on price and quality criteria. As pointed out by Estache and Iimi (2009), there are two reasons for a firm not to participate:

participation costs and minimum quality thresholds that can be used by the public buyer as an instrument to modulate the level of participation.

Why clauses and criteria are not equivalent. In practice, participation costs and quality thresholds do not operate identically for green clauses and green criteria, and it is useful to separate the two channels before turning to the model.

Green criteria significantly increase participation costs, since firms must document the characteristics of the technology they intend to implement. Firms sometimes have to perform assessments and produce original information, for example to provide a carbon footprint. In contrast, firms must comply with green clauses when implementing the contract in order to avoid penalties, but green clauses induce little additional participation cost, as they require no supporting documentation at the bidding stage.

Conversely, no firm is directly prevented from participating because of an environmental award criterion, whereas a green clause may be disqualifying. For clauses, it is therefore of critical importance to determine whether all firms can provide any level of quality at different costs (i.e., *endogenous* quality) or whether some firms simply cannot reach certain quality levels (i.e., *exogenous* quality). In reality, firms are likely capable of adapting their production process only to a certain extent. Typically, since contract performance begins shortly after the award decision, firms do not have time to innovate, so they most likely cannot extend the range of technologies they can implement. Thus, when quality is exogenous, green clauses shrink the pool of eligible candidates as they become more demanding, whereas green criteria leave that pool unchanged.

When quality is endogenous, firms can adapt their production process at a cost. This is the case we model below, and it is the case in which a novel, positive effect on participation arises. The model isolates that positive channel; the two negative channels just described—exclusion for clauses, higher participation costs for criteria—are then reintroduced when we translate the results into empirical predictions.

Overview of the argument. In our model, firms differ in efficiency. Bidding is costly, so a firm submits a bid only if the profit it expects to make—given that it may lose—covers that cost. This defines an efficiency *threshold*: firms above it stay out, firms below it bid. Anything that raises the profit of the firm sitting exactly at the threshold pulls the threshold outward and brings

additional firms into the procedure. The key observation is that a more demanding environmental requirement is not equally costly for everyone. Under the assumption that greening a contract penalizes inefficient firms more than efficient ones—a property we state formally as Assumption 1—raising environmental requirements widens the cost gap between the firms in the running and the least efficient firm in the market. Since it is that gap that a bidder can capture as a margin, greener contracts make bidding more profitable, and therefore more attractive. This is the positive participation channel that the rest of this section formalizes, and it operates for clauses (through a required quality level) and for criteria (through the weight attached to environmental quality) alike.

Set-up. Let $V(q; \lambda)$ denote the public buyer's gross surplus from the performance of a contract with environmental quality q , where the parameter $\lambda > 0$ measures the importance the buyer attaches to environmental quality. Quality is observable and verifiable. We assume $V_q(q; \lambda) > 0$, $V_{qq}(q; \lambda) < 0$, $\lim_{q \rightarrow 0} V_q(q; \lambda) = +\infty$, and $\lim_{q \rightarrow +\infty} V_q(q; \lambda) = 0$. The first two conditions state that environmental quality is valuable but with diminishing returns; the last two guarantee that the optimal quality level is interior. If the buyer pays price p , its utility from a contract (q, p) is $V(q; \lambda) - p$. In the analysis of clauses, λ plays no role and we simply write $V(q)$.

There are $n \geq 2$ risk-neutral firms, indexed by $i = 1, \dots, n$, that may bid for the contract. Preparing and submitting a bid costs $\kappa > 0$, which is sunk whether or not the firm wins.¹ For a given environmental quality q , firm i incurs the production cost $c(\theta_i, q)$, with $c_\theta(\theta_i, q) > 0$ and $c_q(\theta_i, q) > 0$. A higher θ_i therefore denotes a *less* efficient firm, and delivering more environmental quality is costly for every firm. Each firm observes its own type θ_i but knows only the distribution of its competitors' types. Types are drawn independently from a distribution F with support $[\underline{\theta}, \bar{\theta}]$ and continuous density $f = F' > 0$. Throughout, we write $\bar{F}(\theta) \equiv 1 - F(\theta)$ for the probability that a given rival is *less* efficient than a firm of type θ . To clarify the poten-

¹The condition on κ guaranteeing that some—but not all—firms participate is stated explicitly below. To isolate the mechanism of interest, we initially treat κ as independent of the environmental instruments used. This is a deliberate simplification: Propositions 1 and 2 show that participation is strictly decreasing in κ , so any increase in bid-preparation costs caused by these instruments works against the positive effect we identify. We reintroduce this counteracting force when formulating the empirical predictions.

tial relationship between bidder participation and the use of environmental clauses and criteria, we follow Menezes and Monteiro (2000) and assume that firms privately observe their cost of performing the contract *before* deciding whether to participate. This assumption appears appropriate for most procurement contracts, where the technical specifications are published with the call for tenders.

The following two assumptions are used for the comparative statics involving environmental quality.

Assumption 1. *The cost function exhibits weakly increasing differences between inefficiency and quality: $c_{\theta q}(\theta, q) \geq 0$ for all (θ, q) .*

Assumption 1 says that the marginal cost of supplying additional environmental quality is higher for a less efficient firm. Equivalently, making a contract greener hurts laggards more than leaders, so the cost gap between a given firm and its less efficient rivals *widens* as the environmental requirement rises. This assumption delivers the positive participation effect. It is satisfied by the specifications commonly used in this literature—including the multiplicative form $c(\theta, q) = \theta \gamma(q)$ with $\gamma' > 0$ —and it holds with equality (so that our results hold weakly) whenever efficiency and environmental performance are technologically unrelated.

Assumption 2. *The cost function is weakly convex in quality: $c_{qq}(\theta, q) \geq 0$ for all (θ, q) .*

Assumption 2 states that successive increments of environmental quality are increasingly costly. Following Che (1993), we assume that the cost function is not too convex in q , so that the buyer never wishes to split the contract among several firms. This assumption, combined with $V_{qq} < 0$, guarantees that each firm's privately optimal quality level is well defined and unique.

The timing is as follows: (i) the buyer announces the procedure, that is, a required quality q^* (clause) or a weight λ on environmental quality (criterion); (ii) each firm i privately observes θ_i and decides whether to pay κ and bid, without observing how many rivals will do the same; (iii) participating firms submit a bid; (iv) the contract is awarded and performed.

3.1. Participation under an environmental clause

Bidding. Under a clause, the public buyer fixes q^* , the environmental performance that every bidder must deliver. Quality is thus common to all bids and firms compete on price alone: the lowest bid wins. Menezes and Monteiro (2000) derive the optimal bidding strategy in a first-price sealed-bid auction with endogenous participation when price is the only criterion and the highest bidder wins. In our setting both price and quality matter and the lowest bid wins, but the same argument applies. Let $\tilde{\theta}$ denote the entry cutoff, that is, the type such that firm j participates if and only if $\theta_j \leq \tilde{\theta}$. If firm i submits b_i while every rival j follows the symmetric strategy $b_j = b(\theta_j)$, firm i loses whenever at least one rival has $\theta_j < b^{-1}(b_i)$. Its expected profit is

$$E\pi(\theta_i) = [b_i - c(\theta_i, q^*)] \times \left[\bar{F}(\min\{b^{-1}(b_i), \tilde{\theta}\}) \right]^{n-1} - \kappa. \quad (1)$$

Restricting attention to symmetric equilibria and imposing the boundary condition $E\pi(\tilde{\theta}) = 0$, the equilibrium bidding strategy is²

$$\begin{aligned} b(\theta_i) = & c(\theta_i, q^*) + \frac{\kappa}{\bar{F}(\theta_i)^{n-1}} \\ & + \frac{1}{\bar{F}(\theta_i)^{n-1}} \int_{\theta_i}^{\tilde{\theta}} c_{\theta}(\theta, q^*) \bar{F}(\theta)^{n-1} d\theta \quad \text{for } \theta_i < \tilde{\theta}, \end{aligned} \quad (2)$$

and firm i does not participate if $\theta_i > \tilde{\theta}$.

The entry decision. Following Menezes and Monteiro (2000), a firm participates only if its expected profit is non-negative. The marginal entrant $\tilde{\theta}$ is exactly indifferent, i.e.

$$[b(\tilde{\theta}) - c(\tilde{\theta}, q^*)] \bar{F}(\tilde{\theta})^{n-1} - \kappa = 0. \quad (3)$$

A firm of type $\tilde{\theta}$ is the least efficient participant, so it can win only when it happens to be the sole participant. Facing no competitor, it optimally submits the highest bid the buyer would still accept, namely the cost that the least efficient type in the market would incur, $c(\tilde{\theta}, q^*)$. Substituting this reservation bid into (3), the cutoff is implicitly defined by

$$\underbrace{[c(\tilde{\theta}, q^*) - c(\tilde{\theta}, q^*)]}_{\equiv \Delta C(\tilde{\theta}; q^*)} \times \bar{F}(\tilde{\theta})^{n-1} = \kappa. \quad (4)$$

²See Appendix A.1 for a proof.

The left-hand side of (4) is strictly decreasing in $\tilde{\theta}$ —a less efficient marginal entrant has both a thinner margin and a smaller chance of being alone—so the cutoff is unique whenever it exists. An interior cutoff, that is, one in which some but not all firms participate, requires

$$0 < \kappa < c(\bar{\theta}, q^*) - c(\underline{\theta}, q^*), \quad (5)$$

which simply says that bidding must be cheap enough for the most efficient firm in the market to find it worthwhile.

The buyer's choice of q^ .* Anticipating the cutoff and the bidding strategy in (2), the buyer selects the optimal required quality level

$$q^* \in \arg \max_q \left\{ V(q) - \int_{\underline{\theta}}^{\tilde{\theta}(q)} b(\theta; q) n \bar{F}(\theta)^{n-1} f(\theta) d\theta \right\}, \quad (6)$$

where $n \bar{F}(\theta)^{n-1} f(\theta)$ is the density of the most efficient type among n draws.

Comparative statics. Because a firm enters when $\theta_i \leq \tilde{\theta}$, the probability that any given firm submits a bid is $F(\tilde{\theta})$ and the expected number of bids received by the buyer is $n F(\tilde{\theta})$. The cutoff $\tilde{\theta}$ is therefore a direct measure of effective participation, and it is the object whose comparative statics we characterize in the following. Proposition 1 characterizes how participation under a clause responds to κ , n , and q^* treated as *policy parameters*.³

Proposition 1. *Whenever an interior entry cutoff exists, the cutoff $\tilde{\theta}$ defined by (4) is unique and satisfies*

$$\frac{\partial \tilde{\theta}}{\partial \kappa} < 0 \quad \text{and} \quad \frac{\partial \tilde{\theta}}{\partial n} < 0. \quad (7)$$

It also satisfies

$$\frac{\partial \tilde{\theta}}{\partial q^*} \geq 0, \quad (8)$$

with strict inequality whenever $c_{\theta q}(\theta, q^) > 0$ on a positive-measure subset of $(\tilde{\theta}, \bar{\theta})$.*

³See Appendix A.2 for a proof.

The three signs in Proposition 1 have straightforward interpretations.

First, participation falls when bidding becomes more expensive. This is immediate from (4): a larger κ raises the margin a firm must expect in order to justify bidding, and only more efficient firms clear that higher bar.

Second, participation *per firm* falls when the number of potential bidders rises (e.g., via a longer advertising period). When n increases, each firm is less likely to win, so the expected return to bidding falls and the marginal firm withdraws. However, as shown by Menezes and Monteiro (2000), the public buyer may be better off with this decline in participation. Indeed, the remaining firms are the most cost-effective. Knowing that they are competing with other cost-effective firms, it is optimal for them to reduce their margin to win.

Third—and this is the original result—participation weakly *rises* with the required environmental quality. Under Assumption 1, a tougher requirement penalizes the least efficient type $\bar{\theta}$ more than the marginal entrant $\tilde{\theta}$. The gap $\Delta C(\tilde{\theta}; q^*) = c(\bar{\theta}, q^*) - c(\tilde{\theta}, q^*)$, which is precisely the margin the marginal entrant can hope to capture, therefore widens. Bidding becomes more profitable at the margin, and the cutoff moves outward.

Prediction 1. *For a given number of eligible firms and unchanged participation costs, requiring a higher level of environmental quality through a clause weakly increases effective participation. The effect is strict when costs exhibit strictly increasing differences over a non-negligible range of firm types.*

Prediction 1 isolates the endogenous-quality channel and holds the pool of eligible firms fixed. In practice, a more demanding environmental clause may also reduce the number n of firms that are technically able to comply, since contract performance starts too soon after the award for firms to innovate. A green clause therefore raises the *observed* number of bidders only if the entry incentive generated by higher expected margins outweighs the contraction of the eligible pool. Which of the two forces dominates is an empirical question.

3.2. Participation under an environmental criterion

Bidding. Under a criterion, no minimum quality is imposed: each firm chooses its own environmental quality when submitting its bid. As analyzed by Che (1993), the buyer runs a first-score auction. Each participating firm pays κ , submits a price–quality pair (p, q) , and receives the score

$$S(q, p) = V(q; \lambda) - p, \tag{9}$$

the contract going to the highest score. The parameter λ is the weight the buyer attaches to environmental quality and is the theoretical counterpart of the weight announced in the call for tenders.

A firm aiming at any given score wants to deliver that score as cheaply as possible. Following Che (1993), since the cost-minimizing quality is the same whatever the targeted score, firm i chooses⁴

$$q^{**}(\theta_i; \lambda) = \arg \max_q \{V(q; \lambda) - c(\theta_i, q)\}. \quad (10)$$

Given Assumption 2, the solution to (10) is unique, interior and continuously differentiable. Two properties of q^{**} follow and are established in Appendix A.4: chosen quality decreases with inefficiency ($q_\theta^{**} \leq 0$), and it increases with the weight placed on the environment ($q_\lambda^{**} > 0$) whenever $V_{q\lambda} > 0$.

As shown in Appendix A.3, the first-score auction reduces to a standard first-price auction in which each firm i 's effective cost is its *pseudo-cost* $c(\theta_i, q^{**}(\theta_i; \lambda)) - V(q^{**}(\theta_i; \lambda); \lambda)$. The equilibrium price accompanying the quality offer $q^{**}(\theta_i; \lambda)$ therefore mirrors (2):

$$\begin{aligned} b(\theta_i) = & c(\theta_i, q^{**}(\theta_i; \lambda)) + \frac{\kappa}{\overline{F}(\theta_i)^{n-1}} \\ & + \frac{1}{\overline{F}(\theta_i)^{n-1}} \int_{\theta_i}^{\widehat{\theta}} c_\theta(\theta, q^{**}(\theta; \lambda)) \overline{F}(\theta)^{n-1} d\theta \quad \text{for } \theta_i < \widehat{\theta}, \end{aligned} \quad (11)$$

where $\widehat{\theta}$ is the entry cutoff under a criterion. If $\theta_i > \widehat{\theta}$, firm i does not participate. The only difference with (2) is that the common required quality q^* is replaced by each firm's self-selected quality $q^{**}(\theta; \lambda)$.

The entry decision. As before, the marginal entrant is indifferent between bidding and staying out

$$\left[b(\widehat{\theta}) - c(\widehat{\theta}, q^{**}(\widehat{\theta}; \lambda)) \right] \overline{F}(\widehat{\theta})^{n-1} - \kappa = 0. \quad (12)$$

This firm can win only if it is alone, in which case it submits the highest acceptable bid. Applying the same reservation-bid convention as under a

⁴See Appendix A.3 for a proof.

clause—the buyer accepts at most the cost that the least efficient type would incur at the quality actually offered—this bid is $c(\bar{\theta}, q^{**}(\hat{\theta}; \lambda))$, and the cutoff solves

$$\underbrace{\left[c(\bar{\theta}, q^{**}(\hat{\theta}; \lambda)) - c(\hat{\theta}, q^{**}(\hat{\theta}; \lambda)) \right]}_{\equiv \Delta G(\hat{\theta}; \lambda)} \times \bar{F}(\hat{\theta})^{n-1} = \kappa. \quad (13)$$

Equation (13) is the exact analogue of (4), with the margin ΔG now evaluated at the quality the marginal firm chooses for itself. An interior cutoff exists if and only if

$$0 < \kappa < c(\bar{\theta}, q^{**}(\underline{\theta}; \lambda)) - c(\underline{\theta}, q^{**}(\underline{\theta}; \lambda)). \quad (14)$$

Comparative statics.

Proposition 2. *Whenever an interior entry cutoff exists, the cutoff $\hat{\theta}$ defined by (13) is unique and satisfies*

$$\frac{\partial \hat{\theta}}{\partial \kappa} < 0 \quad \text{and} \quad \frac{\partial \hat{\theta}}{\partial n} < 0. \quad (15)$$

If, in addition, $V_{q\lambda}(q; \lambda) > 0$, so that a higher λ raises the marginal value of quality, then

$$\frac{\partial \hat{\theta}}{\partial \lambda} \geq 0, \quad (16)$$

with strict inequality whenever $c_{\theta q} > 0$ on a positive-measure subset of $(\hat{\theta}, \bar{\theta})$ at the relevant quality level.

The mechanism behind (16) is the same as under a clause, with one additional step. A larger λ makes environmental quality more valuable to the buyer, so every firm responds by offering a greener bid ($q_{\lambda}^{**} > 0$). Because greening is more burdensome for inefficient firms (Assumption 1), this shift widens the cost gap between the marginal entrant and the least efficient type, raising the margin ΔG that the marginal entrant can capture. Bidding becomes more attractive and the cutoff moves outward.

Prediction 2. *For a given number of eligible firms and unchanged participation costs, a higher weight on environmental quality weakly increases effective participation. The effect is strict when costs exhibit strictly increasing differences over a non-negligible range of firm types.*

As with Prediction 1, Prediction 2 isolates one channel. It holds participation costs fixed, whereas in practice an environmental criterion is likely to raise κ , since firms must collect, verify and report information about their environmental performance. Since $\partial\hat{\theta}/\partial\kappa < 0$, the observed effect of a green award criterion on participation is positive only if the incentive created by the higher expected margin outweighs this increase in bid-preparation costs.

Taking the model to the data. The model delivers two conditional predictions for the empirical analysis. Both instruments raise participation through the margin channel, and both are opposed by an instrument-specific counterforce (a smaller eligible pool for clauses, higher bidding costs for criteria). The sign of the net effect is theoretically ambiguous and therefore has to be settled empirically. This is what the remainder of the paper does. However, with the available data, a positive association between firm participation and the implementation of green procurement instruments would be consistent with the margin channel, but would not identify it. A negative association would likewise not identify exclusion or participation costs separately.

4. Data

Sample description. The empirical analysis is based on a dataset that centralizes and enhances the content of the award notices published in France (Deschamps and Potin, 2025). We analyze approximately 50,000 observations covering 20,341 public contracts awarded in mainland France between January 2022 and December 2023. Each observation corresponds to a contract lot (or a contract that is not divided into lots).

To align with the theoretical framework of this paper, the sample focuses on public contracts awarded under the open procedure, under which any firm may submit a bid. This implies that the contracting authority does not restrict participation to designated firms or suppliers with specified characteristics.

We restrict the sample to lots for which the required information—namely the number of bidders, the identity of the contracting authority, and the content and weight of award criteria—is available.

We also exclude the lots for which more than ten bids are recorded, to avoid outliers likely driven by data entry errors. For example, some lots are described as receiving over 500 offers, which is implausible. In particular, contracting authorities sometimes indicate the number of bids received for all

lots of the contract rather than the lot considered, resulting in an artificially large number of offers. In the data, only 3.5% of the lots are reported to have received more than ten bids. The impact of this restriction on the results is discussed in Section 7.

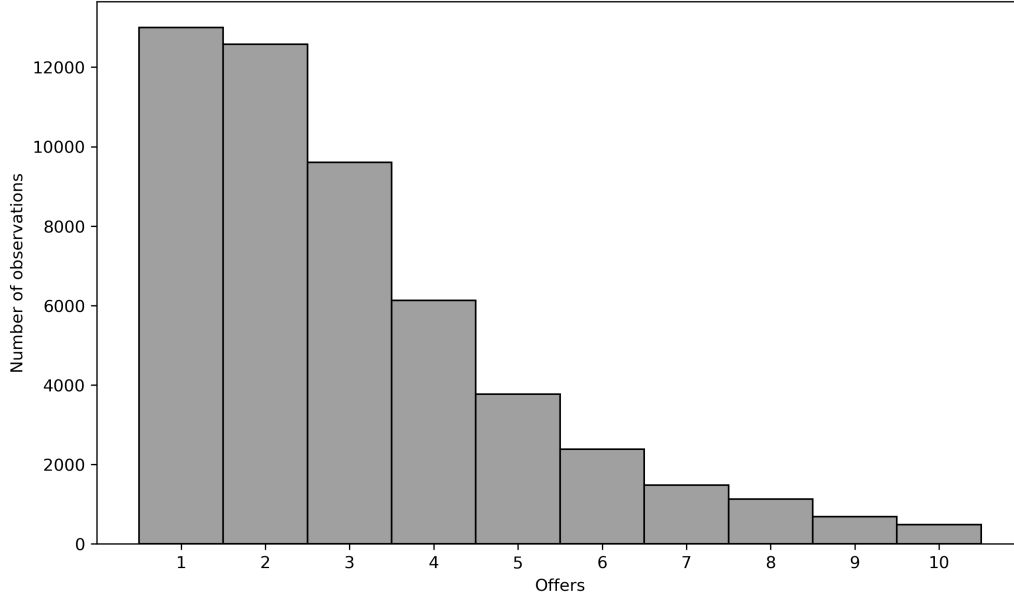


Figure 1: Distribution of the number of offers

47% of the observations in the sample correspond to service contracts, 37% to supply contracts, and 15% to works contracts. As this classification is not sufficiently granular, we use the categorical variable *Sector*, which is based on the Common Procurement Vocabulary (CPV) code of the lot. The CPV is a 9-digit code that standardizes the classification of public contracts in the European Union. It provides a detailed sectoral classification of public procurement.

Variable description. *Offers* is a count variable that denotes the number of offers received by the contracting authority for a given lot. Figure 1 plots the distribution of this variable. As shown in Table 1, the average number of offers is approximately 3.

The dummy variable *G_clause* indicates whether a given lot includes an environmental clause (1) or not (0). 28% of lots in the sample include an environmental clause. Unfortunately, the content of the clauses is not publicly

available, as the BOAMP website only indicates whether such clauses are implemented. Importantly, following the distinction of Drake and Xu (2025), in our sample, green clauses represent a contractual obligation that applies to the firm awarded the contract. As explained above, since green procurement instruments must be related to the subject matter of the contract and not to general characteristics of the bidders, green clauses only apply to the selected firms.

Similarly, $G_criterion$ is a dummy variable that indicates the implementation of an award criterion related to environmental issues in the procurement procedure.⁵ 27% of the observations in the sample include a green award criterion.

The weights of quality award criteria are standardized from 0 to 100. A zero value indicates that the corresponding criterion is not considered when scoring the received offers. A weight equal to 100 indicates that only this dimension is considered when assessing bids. G_weight refers to the weight assigned to environmental criteria, if any, considering observations with and without a green criterion. When a green criterion is used (i.e., when $G_criterion = 1$), its average weight is approximately 12.25%. In contrast, P_weight refers to the weight assigned to the price criterion. This variable is used to control for the importance of quality-related criteria in general in the scoring of the bids.

To avoid collinearity between G_weight and the weight assigned to the bid price, P_weight is equal to the ratio of the weight assigned to the bid price to the sum of the weights assigned to all quality-related criteria, except those related to environmental issues. Figure 2 plots the distribution of the weights assigned to environmental and price-related award criteria. When implemented, the most frequent weight of environmental criteria is 10% of the score, while we observe a significant share of lots where environmental criteria account for 5% of the score. The bid value typically accounts for 30 to 70% of the score.

Regarding control variables, $Allotment$ is a dummy variable indicating

⁵As in Deschamps (2025), since award criteria are not categorized in the online notices, the following list of keywords is used to characterize environmental criteria in the description of the original award criteria: “ENVIRONNEM”, “ENVIRONEM”, “ECOLO”, “ÉCOLO”, “ÉCOSYST”, “ECOSYST”, “ÉCO-SYST”, “ECO-SYST”, “RECYCL”, “RECICL”, “SOUTENABI”, “DURAB”, “CLIMAT”, “CARBO”, “DUREE DE VIE”, “DURÉE DE VIE”

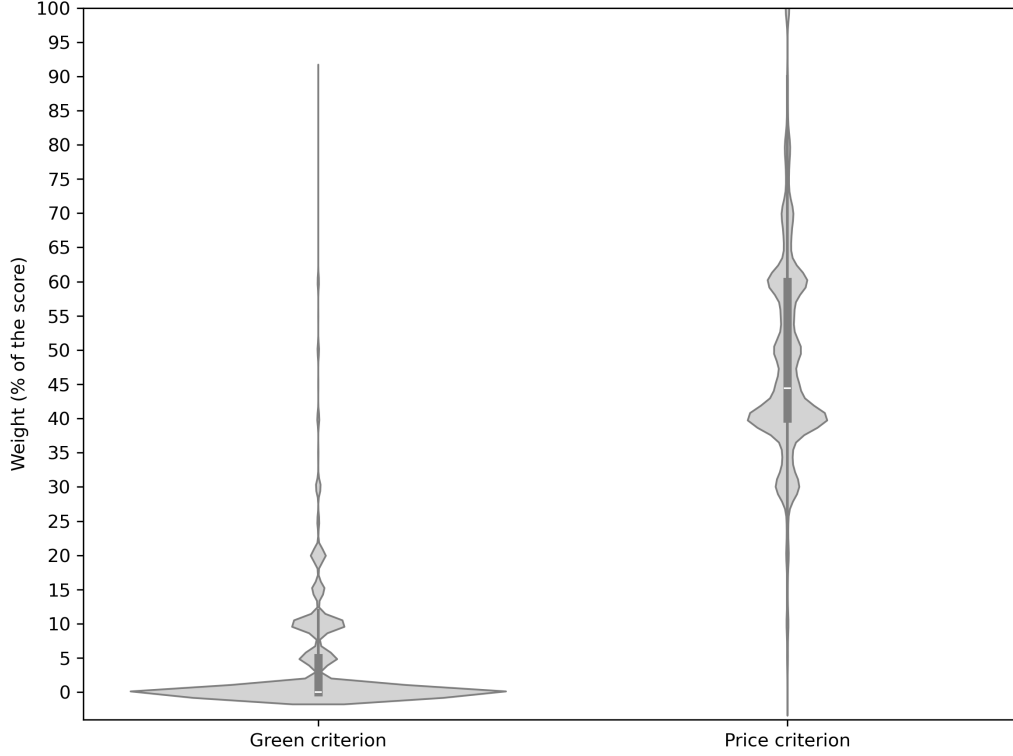


Figure 2: Distribution of award criteria weights

whether a given observation is a lot of a subdivided contract or not. *Framework* is a dummy variable indicating whether the observation belongs to a framework agreement (i.e., contracts that organize the execution of new contracts in the future with the same successful supplier). We categorize contracting authorities into seven groups in the variable *Status*: municipalities, local agencies, municipal federations, “départements”, “régions”, national agencies, and state institutions. Finally, we control for the location of the public buyer with the categorical variable *Region*, based on the 12 “régions” in continental France.

Table B.4 highlights that there is no clear correlation between participation and the inclusion of environmental award criteria or clauses. As expected, the implementation of a green clause is strongly correlated with the implementation of a green criterion. While green clauses and criteria are not strongly correlated with contract characteristics such as allotment

and framework agreements, there is a clear positive association between the weight of the environmental criterion and the share of the score—irrespective of G_weight —that is related to the bid value. This implies that contracting authorities tend to include a restricted number of quality-related award criteria.

Variable	Type	Mean	Definition
<i>Outcome variable</i>			
<i>Offers</i>	Count	3.04	Number of offers received by the contracting authority for a given lot (SD: 2.02)
<i>Green procurement variables</i>			
G_clause	Binary	0.28	= 1 if the lot includes an environmental clause
$G_criterion$	Binary	0.27	= 1 if the lot includes a green award criterion
G_weight	Continuous	3.42	Weight assigned to environmental award criteria (0–100); mean conditional on $G_criterion = 1$: 12.25%
<i>Control variables</i>			
P_weight	Continuous	48.13	Ratio of the price criterion weight to the sum of all non-environmental quality criteria weights.
<i>Allotment</i>	Binary	0.78	= 1 if the observation is a lot of a subdivided contract
<i>Framework</i>	Binary	0.53	= 1 if the observation belongs to a framework agreement
<i>Status</i>	Categorical	—	Type of contracting authority (7 categories: municipalities, local agencies, municipal federations, <i>départements</i> , <i>régions</i> , national agencies, and state institutions)
<i>Region</i>	Categorical	—	Location of the contracting authority

For binary variables, means report the proportion of observations equal to one.

Table 1: Variable definitions and descriptive statistics

5. Econometric strategy

Since the number of offers received by contracting authorities is a count variable, we employ negative binomial regressions, which allow for overdispersion in the data, unlike Poisson models. As we only observe awarded contracts, the outcome variable is strictly positive. Because estimators may

be biased when modeling the distribution conditional on non-negative values rather than strictly positive ones, we use zero-truncated negative binomial regressions.

To ensure that estimates are not biased by the peculiarities of the largest public buyers, we apply sample weights by assigning each observation a weight equal to the inverse frequency of the corresponding contracting authority.

Finally, public procurement covers a wide range of sectors. As there are too many sectors to implement precise sectoral fixed effects while ensuring model convergence, we mainly use multilevel models to estimate an overall relationship between green procurement instruments and firm participation, although models based on fixed effects for broad sectoral categories are also considered for robustness in the general analysis. In the sector-specific analyses, fixed-effect models are used as there is less sectoral diversity to control for.

Let $s[i]$ denote the industry to which lot i belongs. We allow the conditional mean of the number of bids to shift by a sector-specific term, captured by a random intercept $b_{s[i]}$. Let Y_i denote the number of offers received for a lot i . The expected count is modeled as

$$\begin{aligned}
Y_i \mid Y_i > 0, \mathbf{X}_i, b_{s[i]} &\sim \text{TruncNegBin}(\mu_{i|s}, \alpha), \\
\mu_{i|s} &= \frac{\exp(\eta_i + b_{s[i]})}{1 - \Pr(Y_i = 0 \mid \mathbf{X}_i, b_{s[i]})}, \\
\eta_i &= \beta_0 + \beta_1 G_clause_i + \beta_2 G_weight_i + \mathbf{X}_i' \boldsymbol{\gamma}, \\
b_s &\sim \mathcal{N}(0, \sigma_b^2).
\end{aligned} \tag{17}$$

6. Results

General results. Table 2 provides consistent evidence of a moderate positive association between the implementation of green clauses and criteria and the number of bids received by public buyers.

Focusing on the multilevel negative binomial estimates with a linear term in G_weight in the second column, we find that green clauses are associated with a 3% increase in firm participation (95% confidence interval: 1.2% to 4.7%). Similarly, a one-percentage-point increase in the weight of the environmental criterion is associated with a 0.3% increase in the number of

bids, implying that a ten-percentage-point increase could also lead to a 3% increase in firm participation (95% confidence interval: 1.4% to 3.6%). As demonstrated by the first column, sectoral fixed effects based on the first two digits of the CPV codes provide comparable results, with a stronger estimate of G_clause (around 0.07).

Interestingly, when allowing for a quadratic effect of the weight of green criteria on participation in the third column of Table 2, we find that the coefficient on the squared term is significantly negative, indicating that the relationship between the weight assigned to environmental criteria and participation could follow an inverted U-shape. The positive association between the implementation of green criteria and firm participation appears to peak at around 34%. However, as only 1% of lots are assigned a weight above 30%,⁶ this result should probably be interpreted as evidence of a diminishing marginal effect of the weight assigned to green criteria on firm participation.

Regarding control variables, we first find evidence of a negative association between contract allotment and participation. This may seem surprising, as allotment is usually promoted to stimulate participation—especially from SMEs. The weight assigned to the price criterion is also negatively associated with the number of bidders across specifications.

Heterogeneity across procurement sectors. Although green clauses and criteria may positively influence firm participation overall, this relationship can be heterogeneous across sectors, depending on the potential for environmental innovation, market concentration, and substitutability between public and private markets. Table 3 successively focuses on the three main sectors of French public procurement in terms of number of contracts, namely, construction works, environmental services, and medical products, while controlling for sub-sectoral heterogeneity using the first three digits of the CPV codes. Due to a smaller sample size, we only consider a linear relationship between green award criteria and the number of bids.

Interestingly, there appears to be heterogeneity in the relationship between the implementation of green clauses and firm participation across procurement sectors. While green clauses are associated with an increase in the number of bids of roughly 8% in environmental services, green clauses could reduce firm participation by 7% for medical product lots.

⁶And only 4% of lots where a green criterion is implemented.

	Truncated Neg. Bin. (Linear)	Multilevel Trunc. Neg. Bin. (Linear)	Multilevel Trunc. Neg. Bin. (Quadratic)
<i>G_clause</i>	0.073*** (0.009)	0.029*** (0.009)	0.024** (0.009)
<i>G_weight</i>	0.002** (0.001)	0.003*** (0.001)	0.005*** (0.001)
<i>G_weight</i> ²	—	—	(-7.46×10^{-5})* (3.55×10^{-5})
<i>Allotment</i>	-0.023** (0.008)	-0.053*** (0.008)	-0.053*** (0.008)
<i>Framework</i>	0.097*** (0.008)	-0.004 (0.008)	-0.005 (0.008)
<i>P_weight</i>	-0.004*** (3.16×10^{-4})	-0.003*** (3.03×10^{-4})	-0.003*** (3.09×10^{-4})
Constant	0.954*** (0.051)	1.017*** (0.040)	1.010*** (0.040)
<i>Status</i>	Yes	Yes	Yes
<i>Region</i>	Yes	Yes	Yes
<i>Sector</i>	F.E.	Random	Random
Standard errors	Robust	Robust	Robust
Sample weights	Yes	Yes	Yes
Observations	49,214	49,214	49,214
Levels	—	146	146
Pseudo- <i>R</i> ²	0.386	0.273	0.274

Robust standard errors in parentheses.

Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 2: General estimates of firm participation

However, in these specific sectors, no significant relationship emerges between green award criteria and firm participation, despite negative estimates with p-values close to 0.10 in construction works and medical products.

Heterogeneity across public buyers. The aggregate estimates may also conceal heterogeneity across types of contracting authorities. We therefore re-estimate the linear multilevel truncated negative binomial model separately for each of the seven categories of public buyers. Table C.5 reports the resulting estimates. Note that Cochran's heterogeneity tests reject the equality of the coefficients across buyer types for both green clauses ($p = 0.023$) and

	CPV 45 Construction Trunc. Neg. Bin.	CPV 90 Environmental services Trunc. Neg. Bin.	CPV 33 Medical products Trunc. Neg. Bin.
<i>G_clause</i>	0.021 (0.017)	0.082*** (0.024)	−0.069* (0.033)
<i>G_weight</i>	−0.002 (0.001)	0.001 (0.002)	−0.003 (0.002)
<i>Allotment</i>	−0.051** (0.017)	−0.093*** (0.023)	−0.110*** (0.032)
<i>Framework</i>	0.082*** (0.016)	−0.066** (0.023)	0.078** (0.030)
<i>P_weight</i>	0.003*** (6.84×10^{-4})	−0.005*** (0.001)	0.005*** (0.001)
Constant	1.096*** (0.057)	1.039*** (0.094)	1.073*** (0.083)
<i>Status</i>	Yes	Yes	Yes
<i>Region</i>	Yes	Yes	Yes
<i>Sector</i>	F.E.	F.E.	F.E.
Standard errors	Robust	Robust	Robust
Sample weights	Yes	Yes	Yes
Observations	7,421	4,281	3,476

Robust standard errors in parentheses.

Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3: Sector-specific estimates of firm participation

the weight assigned to green criteria ($p < 0.001$).

The association between green clauses and participation is positive and statistically significant for “départements”, national agencies, and “régions”. The corresponding incidence-rate ratios indicate that green clauses are associated with approximately 8%, 7%, and 16% more bids, respectively. By contrast, the estimates are smaller and statistically insignificant for local agencies, municipal federations, municipalities, and state institutions.

The association with the weight assigned to green award criteria also appears concentrated among particular types of buyers. A one-percentage-point increase in *G_weight* is associated with approximately 0.7% more bids for local agencies and 1.2% more bids for national agencies. Equivalently, a ten-percentage-point increase corresponds to approximately 7% and 13% more bids in these two subsamples. The estimate for regional authorities

is positive but falls just short of conventional statistical significance ($p = 0.056$), whereas no significant association is found for the remaining buyer categories. Overall, the positive relationship identified in the full sample may not be uniform across contracting authorities, but appears to be driven disproportionately by national agencies and, depending on the instrument considered, regional authorities and local agencies.

7. Robustness

Within-contract correlation. As discussed above, observations correspond to contract lots (or to non-allotted contracts). Because multiple observations may belong to the same contract, they are unlikely to be independent, raising concerns about the influence of within-contract correlation on the results.

To assess whether the significance of the results is driven by within-contract correlation, we implement a subsampling procedure. Specifically, we randomly draw one observation per contract and estimate the quadratic specification from Table 2 on the resulting subsample, repeating this procedure 1,000 times.

Table D.6 reports summary statistics of the bootstrap distribution of the coefficients, and Figure D.3 displays their empirical distribution. The results confirm the robustness of our main findings. The estimated coefficients for G_clause and G_weight remain positive and precisely estimated across replications. The quadratic term remains negative, consistent with diminishing marginal effects, although it is less precisely estimated and only significant in about 55% of replications, due to the smaller sample size.

Treatment endogeneity. The implementation of a green clause or criterion may not act as a random treatment, raising important endogeneity concerns if the factors driving their adoption also affect firm participation. To address this issue, we implement a doubly robust (DR) approach. Specifically, we reweight the sample to account for both the propensity to receive treatment and the unequal representation of contracting authorities.

We first consider the presence of green clauses and criteria as two binary treatments and compute propensity scores using a multinomial logit model (the results are detailed in Table E.7). These propensity weights are then combined with the baseline sampling weights. As shown in Table F.8, the resulting DR estimates—when green clauses and criteria are modeled as binary variables—are consistent with the baseline findings. In particular, we

continue to find a moderate positive association between the implementation of green procurement instruments and participation. The estimates for control variables also remain largely unchanged.

We then extend the analysis by accounting for heterogeneity in the weight assigned to environmental criteria, as the determinants of assigning a low weight may differ from those associated with a high weight. We define three treatment categories for green criteria—low ($G_weight \leq 10\%$), medium ($10\% < G_weight \leq 30\%$), and high ($G_weight > 30\%$)—in addition to the presence of a green clause. We estimate a multinomial logit model to obtain the corresponding propensity scores and again combine them with the sampling weights. This alternative DR specification (Table F.8) confirms the potential positive influence of environmental clauses on participation in procurement procedures. We also continue to find evidence of a quadratic relationship between firm participation and the weight assigned to green award criteria.

Lot value. One may question why we do not include contract value as a control variable. This raises a potential omitted variable concern if contract value affects both participation and the adoption of green clauses and criteria.

We choose not to include it for two reasons. First, contract value may introduce endogeneity, as the award price is itself influenced by firm participation, although the order of magnitude of the value of a given contract is unlikely to change depending on the number of bidders. Second, from a data perspective, the information related to prices in BOAMP notices is sometimes unreliable, with a non-negligible number of observations reporting prices equal to zero or one euro or corresponding to unit prices rather than the total contract value.

As a robustness check, we include contract value using the logarithm of the award price. To avoid implausibly low values, we restrict the sample to contracts with an award price above 1,000 euros, resulting in a slightly smaller sample. Table G.9 shows that the inclusion of the contract value does not affect the results.

Sample restriction. As explained above, the estimates are based on lots that received ten bids or fewer to avoid data entry errors and abnormally high values that may bias the results. However, to ensure that the sign and significance of the results are not driven by this sample restriction, the general model is replicated under a new specification in which we retain lots with

more than ten reported bids unless all lots in the contract report the same bid count and that count is at least as large as the number of lots. Indeed, some of these abnormally high values apparently result from confusion between the total number of bids made for a contract and the number of bids made for a specific lot. Therefore, when the stated number of offers is surprisingly high and constant for all lots of a contract, the contracting authority is likely to have made an input mistake. The results in Table H.10 apply this filter to the observations where the number of bids strictly exceeds ten in models similar to those in Table 2. The table shows that including observations with more than ten offers has little impact on the estimates of green criteria—including the quadratic term—while the positive estimate of green clauses on participation loses statistical significance when considering multilevel models, although it remains positive. The introduction of the procurement procedures with a relatively high number of offers therefore affects the statistical significance of some results, but it does not contradict the evidence of a positive association between green procurement instruments and firm participation, at least among the lots that receive a limited number of bids. Moreover, the level of participation is probably less important in public contracts that attract a high number of bidders.

8. Discussion

Expected margins and firm participation. When considering all procurement sectors simultaneously, the empirical results provide consistent evidence of a modest positive association between the implementation of green clauses and criteria and firm participation in France. This result is consistent with Predictions 1 and 2 in the theoretical model. In addition, the negative association between firm participation and the weight assigned to price among award criteria could highlight the role of expected margins in the decision to participate: placing greater emphasis on quality can attract more bids by increasing margins, whereas only a limited share of firms are able to operate under low-cost business models.

Decreasing marginal effect of green criteria. Interestingly, the weight assigned to environmental quality in the scoring of bids appears to have a quadratic influence on participation, suggesting a decreasing marginal effect on participation. While there is theoretically no direct link between participation costs and the weight assigned to green criteria, in practice criteria

assigned higher weights are likely to entail greater participation costs than criteria assigned lower weights. For instance, contracting authorities may require more documentation or more detailed information when environmental considerations play a larger role in bid scoring. As a result, higher participation costs could partially offset the stimulating effect of higher expected margins as the weight assigned to green criteria increases.

Heterogeneity across procurement sectors. The influence of green clauses and criteria on firm participation could differ across procurement sectors. In particular, when analyzing the influence of green clauses on the number of bids, we find a positive estimate in environmental services and a negative one in medical products. This suggests that the moderate intensity of the overall stimulating influence of green procurement instruments on firm participation conceals sectoral heterogeneity, depending on sectoral characteristics such as market concentration and the potential for environmental innovation. Although the peculiarities of each procurement sector are difficult to measure, innovation in medical equipment is probably mostly driven by safety, reliability, and higher efficiency rather than environmental considerations. As suggested by the theoretical framework of this paper, the negative effect of green requirements on firm participation due to the exclusion of potential bidders may more than offset the stimulating effect of higher expected margins, leading to lower participation. In contrast, environmental services such as waste processing or sanitation are probably more favorable to environmental innovation, limiting the negative effect of green clauses on firm participation. In this sector, green clauses can effectively reward environmental innovation through higher margins.

Heterogeneity across public buyers. The mechanisms underlying the heterogeneity in the effect of green procurement instruments on firm participation across public buyers are difficult to identify precisely. Differences in market structure, procurement practices, contract characteristics, and administrative capacity may all contribute to the observed variation. Nevertheless, the comparatively strong estimates obtained for national agencies suggest that the quality of environmental provisions may play a role. National-level bodies may possess greater expertise and resources to formulate environmental clauses and award criteria that are clear and proportionate. Better-designed provisions may reduce uncertainty and compliance costs for potential bidders while allowing environmentally capable firms to anticipate higher returns

from participation. We do not find a similar association on firm participation when focusing on the national government, but this could be due to a smaller sample size limiting the statistical power of the model. More generally, due to the strong limitations in the description of green procurement instruments, the observed heterogeneity should be regarded as suggestive evidence rather than a direct test of differences.

Allotment. Surprisingly, in the general model, as well as in sector-specific estimates, contract allotment is negatively associated with firm participation. This result is unexpected, as allotment is usually encouraged to favor firm participation, especially from SMEs, by reducing contract size and tailoring each lot to a specific sector of activity. Deschamps (2025) does not find a significant association between allotment and SME participation, after controlling for the number of offers from larger firms. Although the negative relationship between allotment and firm participation apparently matches our theoretical model, whereby increasing the pool of potential candidates decreases effective participation, other unobserved factors, such as greater contract complexity, can explain this negative association.

Result validity. These results illustrate the theoretical predictions of this paper but do not establish their empirical validity. First, the econometric approach is based on associations rather than causality. We were unable to identify a suitable natural experiment for the contracts and period covered by the data. Second, the theoretical model is based on factors that cannot be observed with available data in France, especially regarding firm margins. Although we can observe bid value—despite limited reliability—it is difficult to assess bidders’ margins. In addition, we lack information on production costs and firm environmental innovation. The empirical results corroborate the theoretical predictions by being compatible with them regarding the positive influence of green procurement instruments on participation and the negative influence of the price criterion on firm participation, but they do not directly prove them.

Unobserved characteristics of clauses and criteria. The precise content of green clauses and award criteria studied in this paper remains uncertain, as this information is not publicly available online. To the best of our knowledge, there is no centralized dataset that precisely documents the content of environmental clauses and award criteria in France. Regarding award criteria related to the environmental quality of bids, we use their assigned weights to

approximate their potential influence on participation. However, Bergman and Lundberg (2013) and Lundberg et al. (2015a) argue that weights should not be used to assess environmental quality criteria. Indeed, stipulated weights are scale-dependent: knowing the assigned weight without the associated scoring rule does not reveal the actual importance attributed to the environmental characteristics of the bid. This imprecision may explain why we find a modest effect of the weight assigned to environmental criteria, as this weight is only a proxy for the true reward given to environmental quality.

Similarly, because we do not observe the content of environmental clauses, we model them as a binary variable. However, there is likely substantial heterogeneity in their stringency. Some clauses may be highly demanding, while others may reflect a mere greenwashing signal on the part of the contracting authority. The modest magnitude of the estimated effect of green clauses may thus be explained by this unobserved heterogeneity. Stringent green clauses may exert a much stronger influence on participation than shallow ones. Importantly, while the content of the green clauses remains unobserved, these provisions require the implementation of green technologies when performing the contract, which affects only the firm awarded the contract. The modest magnitude of the relationship between green clauses and firm participation estimated in this paper does not result from the ambivalence in the nature of clauses stressed by the theoretical framework of Drake and Xu (2025), in which contractual requirements can have a mixed influence on participation if they affect all participants or the successful bidder only.

Comparison with existing studies. Our findings differ at first sight from those of Arve and Desrieux (2026), who document a negative association between environmental considerations and bidder participation using public contracts awarded by large French municipalities and metropolitan authorities between 2017 and 2019. In their preferred specification, the inclusion of an environmental requirement is associated with approximately 0.5 fewer bidders, corresponding to a reduction of around 12.5% relative to the average level of participation. Several differences between the two studies may account for these apparently divergent results. First, the samples cover different segments of French public procurement, as Arve and Desrieux (2026) focus on contracts awarded by large cities and metropolitan authorities, while our sample includes a broader range of contracting authorities and procurement sectors. Note that when considering heterogeneity across contracting authority categories, we find no significant association when focusing on mu-

municipalities. Second, these two studies cover different periods. The 2017–2019 period immediately followed the transposition of Directive 2014/24/EU into French law, when firms may still have been adapting their technologies and bidding practices to the growing use of environmental considerations. By 2022–2023, these requirements may have become more familiar, reducing the associated entry and compliance costs. Third, the variables related to green procurement are not equivalent: the extensive indicator used by Arve and Desrieux (2026) encompasses several forms of environmental consideration, including qualification requirements, award criteria, and contractual clauses, whereas we distinguish between green clauses and the weight assigned to environmental award criteria. Moreover, our sector-specific estimates reveal heterogeneous relationships, with green clauses being positively or negatively associated with participation depending on the sectors.

Using data similar to ours and controlling for the number of bids from larger firms, Deschamps (2025) finds an overall positive association between SME participation and the implementation of green clauses and criteria. This past work suggests that the potential stimulating effect of green procurement instruments we document in this paper could be even stronger for small bidders. This could be due to a stronger potential for environmental innovation and tighter financial constraints that make contracts with greater potential margins more appealing, for example. Note that the earlier study does not consider a potential quadratic influence of green procurement instruments on SME participation. Deschamps (2025) also identifies sectoral heterogeneity in the association between green procurement and SME participation, with green procurement apparently playing no significant role in some industries while exerting a stronger influence in others. However, the earlier study does not identify a significant negative relationship between green procurement and SME participation in any of the sectors considered. Interestingly, both papers identify a positive influence of green clauses on participation when focusing on environmental services, suggesting that environmental requirements could attract firms in general and small ones in particular.

Anticipation of high participation. The implementation of green clauses and criteria can be endogenous, as contracting authorities may introduce green clauses and criteria when they anticipate a high level of participation. This limitation is difficult to address in practice because there may be unobserved factors influencing the attractiveness of a procedure in addition to the control variables already used. However, the objection that contracting authorities

anticipate high participation before implementing green clauses and criteria assumes that contracting authorities can anticipate the number of offers they will receive. This might not be the case for most contracting authorities, since the number of offers they receive is typically low, regardless of the implementation of green clauses and criteria. Additionally, the fact that we do not find evidence of a significantly positive relationship between firm participation and green procurement instruments when focusing on municipalities, consistent with Arve and Desrieux (2026), is another argument against the hypothesis that green procurement is implemented when contracting authorities anticipate a high level of participation. Indeed, while municipal authorities are probably better informed about local firms than other types of contracting authority and may therefore be more prone to anticipating the number of participants, these two studies do not find a stronger positive association between green procurement and participation at the municipal level. Finally, we find evidence of negative associations between green procurement instruments and firm participation in some sectors, which suggests that public buyers do not systematically implement green clauses and criteria when they anticipate a high level of participation.

Policy recommendations. The theoretical and empirical findings of this paper suggest that green clauses and criteria can stimulate the participation of firms in procurement procedures. Therefore, the increasing integration of environmental considerations into public procurement is unlikely to account for the observed structural decline in participation.

However, the mandatory implementation of green clauses and criteria required by the “Climat et Résilience” law may affect their average quality and clarity. Before 2026, such clauses and criteria have remained optional and been implemented by contracting with sufficient expertise and capacity in green procurement. Typically, in this paper we observe a much stronger positive influence of green clauses and criteria on participation when these instruments are implemented by national agencies. By contrast, mandatory implementation by subnational governments with less expertise in green procurement may lead to poorly specified environmental requirements, which could deter firms from participating by being too stringent or raising participation costs to an extent that offsets the stimulating effect on expected margins. In addition, the “Climat et Résilience” law also applies to smaller contracting authorities that are not covered in the sample used in this paper, as data are limited to advertised contract notices. Consequently, providing

adequate training to public buyers working in small institutions is essential.

Although green clauses and criteria could increase firm participation, we show that this increase may not induce lower prices for contracting authorities. Indeed, this paper highlights from both theoretical and empirical perspectives that procedures prioritizing low bids are less attractive. Green public procurement tends to increase firm margins, potentially leading to higher prices despite higher participation, which can be seen as a subsidy for environmental innovation.

9. Conclusion

This paper examines whether environmental clauses and award criteria influence bidder participation in public procurement.

From a theoretical perspective, we show that, within a framework of multidimensional bids with endogenous quality, green clauses and award criteria can increase the number of bidders by expanding expected margins if they do not exclude too many potential bidders or excessively increase participation costs. We thereby highlight that a higher number of participants does not imply lower prices, questioning the relevance of focusing on the number of participants when shaping public procurement policies.

Following these theoretical predictions, using data on 50,000 procurement procedures in France between 2022 and 2023, we find that green clauses and criteria are associated with a slight increase in the number of bids received by contracting authorities, despite sectoral heterogeneity.

Overall, this paper suggests that green public procurement is unlikely to be a structural driver of the current decline in the participation of firms in public procurement.

Acknowledgments

We are grateful to the two anonymous reviewers and to the Editors for their thoughtful and constructive comments, which greatly improved the manuscript. We also thank the participants at IOEA 2026, particularly Kamilla Timerbulatova and Ruben Enikolopov, for their valuable feedback and suggestions.

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Appendix A. Proofs of the theoretical model

Appendix A.1. Equilibrium bidding strategy under an environmental clause

Consider firm i with type θ_i , and suppose all rivals use an increasing bidding function $b(\cdot)$ and enter if and only if their type is below $\tilde{\theta}$. Let $E\pi(\theta_i)$ denote firm i 's expected profit when it bids optimally. In (1), by the envelope theorem, the indirect effect running through the optimal choice of b_i vanishes, and

$$\frac{dE\pi(\theta_i)}{d\theta_i} = -c_\theta(\theta_i, q^*) \left[\bar{F}(b^{-1}(b_i)) \right]^{n-1}. \quad (\text{A1})$$

In a symmetric equilibrium, $b_i = b(\theta_i)$ and hence $b^{-1}(b_i) = \theta_i$, so (A1) becomes

$$\frac{dE\pi(\theta_i)}{d\theta_i} = -c_\theta(\theta_i, q^*) \bar{F}(\theta_i)^{n-1} < 0. \quad (\text{A2})$$

Integrating (A2) and using the boundary condition $E\pi(\tilde{\theta}) = 0$ gives

$$E\pi(\theta_i) = \int_{\theta_i}^{\tilde{\theta}} c_\theta(\theta, q^*) \bar{F}(\theta)^{n-1} d\theta. \quad (\text{A3})$$

Equating (A3) with the expression for expected profit obtained from (1) evaluated at the equilibrium bid,

$$[b(\theta_i) - c(\theta_i, q^*)] \bar{F}(\theta_i)^{n-1} - \kappa = \int_{\theta_i}^{\tilde{\theta}} c_\theta(\theta, q^*) \bar{F}(\theta)^{n-1} d\theta, \quad (\text{A4})$$

and solving for $b(\theta_i)$ yields (2). Since we do not depart from the standard assumptions of the independent private values model, existence and uniqueness of this symmetric equilibrium are guaranteed.

Appendix A.2. Proof of Proposition 1

Define the margin of the marginal entrant and the left-hand side of the entry condition

$$\Psi(\theta; n, q^*) \equiv \Delta C(\theta; q^*) \bar{F}(\theta)^{n-1}, \quad (\text{A5})$$

with $\Delta C(\theta; q^*) \equiv c(\bar{\theta}, q^*) - c(\theta, q^*)$. Equation (4) then reads $\Psi(\tilde{\theta}; n, q^*) = \kappa$.

Step 1: uniqueness of the cutoff. Since $c_\theta > 0$, we have $\Delta C_\theta(\theta; q^*) = -c_\theta(\theta, q^*) < 0$ and $\Delta C(\theta; q^*) > 0$ for $\theta < \tilde{\theta}$. Differentiating,

$$\Psi'(\theta) = \bar{F}(\theta)^{n-2} \left\{ -c_\theta(\theta, q^*) \bar{F}(\theta) - (n-1) \Delta C(\theta; q^*) f(\theta) \right\} < 0. \quad (\text{A6})$$

Because Ψ is continuous and strictly decreasing, with $\Psi(\bar{\theta}) = 0$, equation (4) admits at most one solution, and exactly one when condition (5) holds, since $\Psi(\underline{\theta}) = c(\bar{\theta}, q^*) - c(\underline{\theta}, q^*)$ given $F(\underline{\theta}) = 0$.

Step 2: effect of the participation cost. Applying the implicit function theorem to $\Psi(\tilde{\theta}; n, q^*) - \kappa = 0$,

$$\frac{\partial \tilde{\theta}}{\partial \kappa} = \frac{1}{\Psi'(\tilde{\theta})} < 0. \quad (\text{A7})$$

Step 3: effect of the number of potential bidders. Treating n as continuous for comparative-static purposes and writing $\bar{F}^{n-1} = \exp\{(n-1) \ln \bar{F}\}$,

$$\frac{\partial \Psi}{\partial n} = \Delta C(\tilde{\theta}; q^*) \bar{F}(\tilde{\theta})^{n-1} \ln \bar{F}(\tilde{\theta}) < 0, \quad (\text{A8})$$

the sign following from $0 < \bar{F}(\tilde{\theta}) < 1$ at an interior cutoff, which makes the logarithm negative. Hence

$$\frac{\partial \tilde{\theta}}{\partial n} = -\frac{\partial \Psi / \partial n}{\Psi'(\tilde{\theta})} < 0. \quad (\text{A9})$$

Step 4: effect of the required environmental quality. Differentiating Ψ with respect to q^* ,

$$\frac{\partial \Psi}{\partial q^*} = [c_q(\bar{\theta}, q^*) - c_q(\tilde{\theta}, q^*)] \bar{F}(\tilde{\theta})^{n-1}. \quad (\text{A10})$$

Under Assumption 1, $c_{\theta q} \geq 0$ means that $c_q(\cdot, q^*)$ is nondecreasing in the type; since $\bar{\theta} \geq \tilde{\theta}$, the bracket is nonnegative. A tougher requirement therefore raises the marginal entrant's potential margin, and

$$\frac{\partial \tilde{\theta}}{\partial q^*} = -\frac{\partial \Psi / \partial q^*}{\Psi'(\tilde{\theta})} \geq 0. \quad (\text{A11})$$

The inequality is strict whenever $c_{\theta q}(\theta, q^*) > 0$ on a positive-measure subset of $(\tilde{\theta}, \bar{\theta})$, since the bracket in (A10) is then strictly positive.

Appendix A.3. Equilibrium bidding strategy under an environmental criterion

Under a criterion, firms compete on the score $S(q, p) = V(q; \lambda) - p$ rather than on price alone. We show that this reduces to the problem already solved in Appendix A.1.

Step 1: separating quality from price. Suppose firm i targets a score s . The price consistent with that score is $p = V(q; \lambda) - s$, so the firm's margin is

$$p - c(\theta_i, q) = [V(q; \lambda) - c(\theta_i, q)] - s. \quad (\text{A12})$$

The targeted score s enters additively, so the quality maximizing the margin does not depend on s : whatever score it aims at, firm i chooses $q^{**}(\theta_i; \lambda)$ as defined in (10). Quality choice and score choice are thus fully separable, which is the central insight of Che (1993).

Step 2: the pseudo-cost. Define

$$k(\theta; \lambda) \equiv c(\theta, q^{**}(\theta; \lambda)) - V(q^{**}(\theta; \lambda); \lambda). \quad (\text{A13})$$

Using (A12), the margin of a firm that wins with score s is $-s - k(\theta; \lambda)$. Writing $\beta \equiv -s$, the game is formally identical to a first-price procurement auction in which the firm has cost $k(\theta; \lambda)$ and bids β : the lowest β wins and earns $\beta - k(\theta; \lambda)$.

Step 3: the derivative of the pseudo-cost. Because $q^{**}(\theta; \lambda)$ maximizes $V(q; \lambda) - c(\theta, q)$, the envelope theorem applied to (A13) gives

$$k_\theta(\theta; \lambda) = c_\theta(\theta, q^{**}(\theta; \lambda)) > 0. \quad (\text{A14})$$

The indirect effect of θ through the chosen quality vanishes: to first order, the information rent can be computed *as if* quality were held fixed at the firm's own optimum. In particular, k is increasing, so the most efficient firm still wins.

Step 4: transposing the equilibrium. Applying Appendix A.1 to the auction in (β, k) , with cutoff $\hat{\theta}$, yields

$$\beta(\theta_i) = k(\theta_i; \lambda) + \frac{\kappa}{\overline{F}(\theta_i)^{n-1}} + \frac{1}{\overline{F}(\theta_i)^{n-1}} \int_{\theta_i}^{\hat{\theta}} c_\theta(\theta, q^{**}(\theta; \lambda)) \overline{F}(\theta)^{n-1} d\theta. \quad (\text{A15})$$

Converting back to a price using $p = V(q^{**}(\theta_i; \lambda); \lambda) + \beta(\theta_i)$ and the definition (A13) of k gives exactly (11).

Appendix A.4. Proof of Proposition 2

Step 1: chosen quality falls with inefficiency. The first-order condition for an interior optimum in (10) is

$$V_q(q^{**}(\theta; \lambda); \lambda) = c_q(\theta, q^{**}(\theta; \lambda)). \quad (\text{A16})$$

Because $V_{qq} < 0$ and $c_{qq} \geq 0$ (Assumption 2), the second-order condition $V_{qq} - c_{qq} < 0$ holds strictly, so q^{**} is well defined. Differentiating (A16) with respect to θ and applying the implicit function theorem,

$$q_\theta^{**}(\theta; \lambda) = \frac{c_{\theta q}(\theta, q^{**}(\theta; \lambda))}{\underbrace{V_{qq}(q^{**}(\theta; \lambda); \lambda) - c_{qq}(\theta, q^{**}(\theta; \lambda))}_{<0}} \leq 0, \quad (\text{A17})$$

since the numerator is nonnegative under Assumption 1. Less efficient firms voluntarily offer less environmental quality, which is intuitive: greening is more expensive for them.

Step 2: the marginal entrant's margin falls with inefficiency. Define

$$\Delta G(\theta; \lambda) \equiv c(\bar{\theta}, q^{**}(\theta; \lambda)) - c(\theta, q^{**}(\theta; \lambda)). \quad (\text{A18})$$

Note that both terms are evaluated at the *same* quality, the one the marginal entrant would offer. Differentiating with respect to θ , and recalling that θ affects ΔG both directly and through q^{**} ,

$$\frac{\partial \Delta G(\theta; \lambda)}{\partial \theta} = \underbrace{[c_q(\bar{\theta}, q^{**}) - c_q(\theta, q^{**})]}_{\geq 0 \text{ by Ass. 1}} \times \underbrace{q_\theta^{**}(\theta; \lambda)}_{\leq 0 \text{ by Step 1}} \underbrace{- c_\theta(\theta, q^{**}(\theta; \lambda))}_{< 0} < 0. \quad (\text{A19})$$

Moreover $\Delta G(\theta; \lambda) > 0$ for $\theta < \bar{\theta}$, since $c_\theta > 0$.

Step 3: uniqueness and the effects of κ and n . Let

$$H(\theta; n, \lambda) \equiv \Delta G(\theta; \lambda) \bar{F}(\theta)^{n-1}, \quad (\text{A20})$$

so that (13) reads $H(\hat{\theta}; n, \lambda) = \kappa$. Since $\Delta G > 0$ and $\Delta G_\theta < 0$, the argument of Step 1 of Appendix A.2 applies verbatim and gives $H'(\theta) < 0$. The cutoff is therefore unique, and

$$\frac{\partial \hat{\theta}}{\partial \kappa} = \frac{1}{H'(\hat{\theta})} < 0, \quad \frac{\partial \hat{\theta}}{\partial n} = -\frac{\Delta G(\hat{\theta}; \lambda) \bar{F}(\hat{\theta})^{n-1} \ln \bar{F}(\hat{\theta})}{H'(\hat{\theta})} < 0. \quad (\text{A21})$$

Step 4: chosen quality rises with the environmental weight. Differentiating (A16) with respect to λ ,

$$q_{\lambda}^{**}(\theta; \lambda) = \frac{V_{q\lambda}(q^{**}(\theta; \lambda); \lambda)}{\underbrace{c_{qq}(\theta, q^{**}(\theta; \lambda)) - V_{qq}(q^{**}(\theta; \lambda); \lambda)}_{>0}} > 0 \quad (\text{A22})$$

whenever $V_{q\lambda} > 0$. A heavier weight on environmental quality therefore induces every firm to submit a greener offer.

Step 5: effect of the environmental weight on participation. Holding θ fixed, λ affects ΔG only through the chosen quality, so

$$\frac{\partial \Delta G(\theta; \lambda)}{\partial \lambda} = \underbrace{[c_q(\bar{\theta}, q^{**}) - c_q(\theta, q^{**})]}_{\geq 0 \text{ by Ass. 1}} \times \underbrace{q_{\lambda}^{**}(\theta; \lambda)}_{>0 \text{ by Step 4}} \geq 0. \quad (\text{A23})$$

The margin available to the marginal entrant thus weakly increases with λ , and therefore

$$\frac{\partial \hat{\theta}}{\partial \lambda} = -\frac{\partial H / \partial \lambda}{H'(\hat{\theta})} \geq 0, \quad (\text{A24})$$

with strict inequality whenever $c_{\theta q} > 0$ on a positive-measure subset of $(\hat{\theta}, \bar{\theta})$ at the relevant quality level.

Appendix B. Correlation matrix

	<i>Offers</i>	<i>G_clause</i>	<i>G_weight</i>	<i>P_weight</i>	<i>Allotment</i>	<i>Framework</i>
<i>Offers</i>	1.00	0.03	-0.01	-0.05	-0.05	0.04
<i>G_clause</i>	0.03	1.00	0.26	0.08	0.04	0.07
<i>G_weight</i>	-0.01	0.26	1.00	0.36	0.04	0.07
<i>P_weight</i>	-0.05	0.08	0.36	1.00	0.04	0.02
<i>Allotment</i>	-0.05	0.04	0.04	0.04	1.00	0.01
<i>Framework</i>	0.04	0.07	0.07	0.02	0.01	1.00

Table B.4: Correlation matrix

Appendix C. Results by type of contracting authority

	Département	Local agency	Municipal fed.	Municipality	National agency	Région	State
<i>G_clause</i>	0.075** (0.023)	0.010 (0.018)	−0.001 (0.022)	0.022 (0.015)	0.069** (0.026)	0.145** (0.050)	0.032 (0.053)
<i>G_weight</i>	0.001 (0.001)	0.007*** (0.001)	−0.002 (0.001)	0.001 (0.001)	0.012*** (0.002)	0.008 (0.004)	0.003 (0.005)
<i>Allotment</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Framework</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>P_weight</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Region</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Sector</i>	Random	Random	Random	Random	Random	Random	Random
Standard errors	Robust	Robust	Robust	Robust	Robust	Robust	Robust
Sample weights	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,263	11,545	9,729	14,226	4,238	2,156	1,057
CPV levels	142	143	144	145	134	96	105

Robust standard errors in parentheses. All models include a random intercept for three-digit CPV sectors. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table C.5: Estimates of firm participation by type of public buyer

Appendix D. Robustness: bootstrap estimators

Variable	Mean	SE	95% CI	99% CI	Significance rate (%)
G_clause	0.031	0.005	[0.021, 0.041]	[0.019, 0.043]	96.1
G_weight	0.006	0.001	[0.004, 0.007]	[0.004, 0.007]	99.9
G_weight^2	-8.76e-5	1.67e-5	[-1.21e-4, -5.7e-5]	[-1.28e-4, -4.83e-5]	55.3

Table D.6: Bootstrap summary statistics

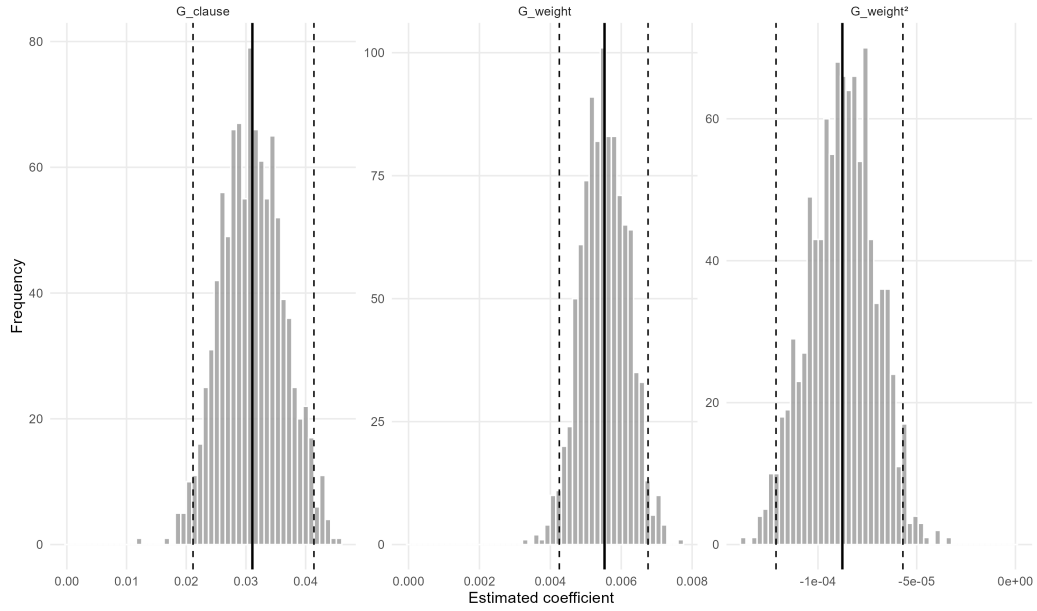


Figure D.3: Distribution of bootstrap estimators (median and 95% confidence interval)

Appendix E. Robustness: full multinomial logistic regressions

	Clause only	Criterion only	Both
<i>Allotment</i>	0.261***	0.285***	0.100***
<i>Framework</i>	0.123***	0.373***	0.379***
<i>P_weight</i>	-0.005***	0.040***	0.032***
Constant	-1.500***	-3.872***	-2.296***
Region Auvergne-Rhône-Alpes	Reference	Reference	Reference
Region Bourgogne-Franche-Comté	0.147	0.106	-0.156
Region Bretagne	0.158	0.127	-0.278***
Region Centre-Val de Loire	0.346***	0.182	-0.082
Region Grand Est	0.181***	0.014	-0.465***
Region Hauts-de-France	0.161**	-0.602***	-0.675***
Region Ile-de-France	0.231***	0.642***	0.127**
Region Normandie	0.024	-0.055	-0.222***
Region Nouvelle-Aquitaine	0.029	0.454***	-0.022
Region Occitanie	0.232***	-0.503***	-0.771***
Region Pays de la Loire	0.284***	0.349***	-0.313***
Region Provence-Alpes-Côte d'Azur	-0.224***	-0.254***	-0.705***
Status Departement	Reference	Reference	Reference
Status Local agencies	-0.042	0.443***	-0.377***
Status Municipal federation	0.240***	0.450***	-0.243***
Status Municipality	0.360***	0.314***	-0.117**
Status National agencies	0.476***	0.133	-0.012
Status Region	1.130***	0.247**	-1.591***
Status State	1.502***	-0.155	0.127
<i>Sector</i>	Yes	Yes	Yes
Standard errors	Basic	Basic	Basic
Observations	49,214	49,214	49,214
Pseudo- R^2	0.122	0.122	0.122

Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Reference category: no clause or criterion.

Table E.7: Multinomial logistic regressions of green clauses and criteria

Appendix F. Robustness: doubly robust estimators

	Multilevel Trunc. Neg. Bin. (Binary DR)	Multilevel Trunc. Neg. Bin. (Linear DR)	Multilevel Trunc. Neg. Bin. (Quadratic DR)
G_clause	0.028*** (6.43×10^{-3})	0.049*** (8.01×10^{-3})	0.045*** (8.15×10^{-3})
$G_criterion$	0.032*** (6.50×10^{-3})	—	—
G_weight	—	0.004*** (5.58×10^{-4})	0.006*** (1.17×10^{-3})
G_weight^2	—	—	(-8.50×10^{-5})* (3.97×10^{-5})
$Allotment$	-0.048*** (5.92×10^{-3})	-0.053*** (7.63×10^{-3})	-0.053*** (7.63×10^{-3})
$Framework$	0.008 (5.85×10^{-3})	-0.003 (7.39×10^{-3})	-0.003 (7.39×10^{-3})
P_weight	-0.002*** (2.19×10^{-4})	-0.003*** (2.90×10^{-4})	-0.003*** (2.90×10^{-4})
Constant	1.122*** (0.030)	1.018*** (0.040)	1.015*** (0.040)
$Status$	Yes	Yes	Yes
$Region$	Yes	Yes	Yes
$Sector$	Random	Random	Random
Standard errors	Robust	Robust	Robust
Sample weights	Yes	Yes	Yes
Observations	49,214	49,214	49,214
Levels	146	146	146
Pseudo- R^2	0.210	0.296	0.296

Robust standard errors in parentheses.

Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.8: Results with doubly robust estimators

Appendix G. Robustness: impact of the award value

	Truncated Neg. Bin.	Multilevel Trunc. Neg. Bin.
<i>G_clause</i>	0.050*** (9.16×10^{-3})	0.030*** (8.77×10^{-3})
<i>G_weight</i>	0.002* (6.06×10^{-4})	0.002** (5.82×10^{-4})
$\log(\textit{Award_price})$	0.020*** (2.55×10^{-3})	0.030*** (2.50×10^{-3})
<i>Allotment</i>	-0.020* (8.40×10^{-3})	-0.030*** (8.24×10^{-3})
<i>Framework</i>	0.020** (8.04×10^{-3})	-0.009 (7.83×10^{-3})
<i>P_weight</i>	-0.004*** (3.18×10^{-4})	-0.003*** (3.11×10^{-4})
Constant	0.790*** (0.060)	0.680*** (0.050)
<i>Status</i>	Yes	Yes
<i>Region</i>	Yes	Yes
<i>Sector</i>	F.E.	Random
Standard errors	Robust	Robust
Sample weights	Yes	Yes
Observations	47,812	47,812
Levels	146	146
Pseudo- R^2	0.386	0.285

Robust standard errors in parentheses.

Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table G.9: Models including award values

Appendix H. Robustness: impact of the sample restriction

	Truncated Neg. Bin. (Linear)	Multilevel Trunc. Neg. Bin. (Linear)	Multilevel Trunc. Neg. Bin. (Quadratic)
<i>G_clause</i>	0.030** (0.010)	0.011 (0.010)	0.004 (0.010)
<i>G_weight</i>	0.003*** (6.64×10^{-4})	0.002** (6.46×10^{-4})	0.005*** (0.002)
<i>G_weight</i> ²	—	—	(-1.02×10^{-4})* (4.51×10^{-5})
<i>Allotment</i>	0.043*** (0.009)	0.028** (0.009)	0.027** (0.009)
<i>Framework</i>	0.055*** (0.009)	0.028** (0.009)	0.028** (0.009)
<i>P_weight</i>	-0.004*** (3.47×10^{-4})	-0.002*** (3.41×10^{-4})	-0.002*** (3.47×10^{-4})
Constant	1.080*** (0.057)	1.110*** (0.045)	1.100*** (0.045)
<i>Status</i>	Yes	Yes	Yes
<i>Region</i>	Yes	Yes	Yes
<i>Sector</i>	F.E.	Random	Random
Standard errors	Robust	Robust	Robust
Sample weights	Yes	Yes	Yes
Observations	50,214	50,214	50,214
Levels	—	146	146
Pseudo- <i>R</i> ²	0.468	0.287	0.287

Robust standard errors in parentheses.

Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table H.10: Estimates after relaxing the upper bid-count restriction