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Sustainable Public Procurement, Bidding Behavior and Costs: Evidence from Spanish Contracts.

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Sustainable Public Procurement, Bidding Behavior and Costs: Evidence from Spanish Contracts.[1]

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Abstract

In recent years, sustainability considerations have gained traction and are increasingly included in public procurement auctions. However, evidence on the outcomes of this practice remains limited. This paper presents empirical evidence for Spain regarding the impact of sustainable award criteria (SAC) on firm bidding behavior and on a measure of observed contract costs relative to estimated costs, akin to cost discounts or rebates. Our findings reveal that neglecting potential sources of endogeneity can result in an erroneous positive association between SAC utilization and the number of firms that choose to bid, while potentially overlooking cost impacts. To mitigate potential biases, we leverage a regulatory change -the implementation in Spain of the most recent EU Directive on Public Procurement- which induced contracting authorities to significantly increase SAC adoption. By considering this dynamic, we unveil a negative impact of SAC on the number of received bids, present both in environmental award criteria (-5.6%) and socially responsible award criteria (-8.3%). We further find, for environmental award criteria, evidence of a decrease in discounts (-1 percentage point). We argue that this is a lower bound of the real cost impact of the measure.

Keywords: Sustainable Public Procurement - Sustainable Award Criteria – Bidding Behavior – Competition - Procurement Costs

JEL: D44 - D22 - H57 - Q01

1. Introduction

Public procurement is a process by which public entities purchase goods, works and services. This is a primary channel for the transfer of public funds into private hands, and typically constitutes a significant portion of the economy. Given its size, and recent evidence showing positive impacts for winning firms, policymakers are interested in harnessing this economic activity to achieve sustainability goals beyond the primary objective of procurement. This approach, known as sustainable public procurement (SPP), encompasses both green (GPP) and socially responsible (SRPP) practices. SPP is on the rise, particularly in Europe, where there has been a notable shift from merely allowing it to recommending and employing it more widely. Furthermore, ongoing discussions centre around the expansion of stringent mandatory sustainability requirements in public contracts (Janssen & Caranta, 2023). This is fuelled by recent evidence that suggests that a rigorous

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approach may be more effective in achieving changes in public procurement practices, especially in cases of low government effectiveness (Bosio et al., 2022).

However, while sustainability becomes increasingly popular, and proponents argue for a more rigorous approach, the question of whether employing public procurement for secondary objectives is a sound practice remains a topic of debate. It has been suggested that incompetence is an important factor in public procurement (Bandiera et al., 2009), which puts the correct implementation of the desired policies into question. Moreover, unlike standard regulations affecting all market players, sustainable procurement directly impacts firms working with the government (Marron, 1997 & Marron, 2004). Private market dynamics may either reinforce or counteract intended effects[3]. In addition, establishing policy effectiveness alone is insufficient; efficiency should also be considered by comparing sustainable procurement to alternatives like taxes and subsidies. Unfortunately, empirical evidence on its effectiveness and efficiency is limited (Cheng et al., 2018).

Sustainability can be integrated into the procurement process at different key stages. It can be introduced right from the start when selecting the procurement model[4], during the design of technical specifications, by incorporating it into the award criteria, or through contract clauses. Importantly, it has been argued that intervening at either the early stages (when deciding what to buy) or in the later stages (contract management phase, through contract performance conditions) reduces the risk of violating the primary goals of procurement[5]. Conversely, the qualification and awarding stages are more likely to distort the competitive process (Trybus, 2020). Despite this, the introduction of sustainable award criteria (SAC) is today a common form of sustainable procurement. The effect that this practice has on contract performance is not clear and evidence of its impacts remains limited.

In this paper, we provide evidence of how SAC impact firm entry to the public procurement competition, as well as how they affect a measure of observed contract costs relative to estimated costs, akin to cost discounts or rebates with respect to reserve prices. To do this, we use Spanish contracts from Tenders Electronic Daily (TED)[6], exploiting the award criteria text information to identify the contracts for which SAC is implemented.

An initial descriptive analysis shows positive associations between the use SAC and the number of received bids. This result is mainly driven by the inclusion of environmental award criteria

[3] If the government policy is successful at reducing the costs of purchasing sustainable products or at increasing market acceptance, there could be the desired reinforcing effect. However, it could also lead to private purchasing becoming browner if it results in higher relative prices for non-sustainable goods and services.
[4] For example, when procuring foods, buying an external service, such as a canteen service, instead of providing in-house the food for workers.
[5] These primary objectives typically encompass achieving value for money, fostering competition and ensuring non-discrimination and transparency.
[6] TED includes information on all public procurement contracts awarded in the European Economic Area whose monetary value exceeds certain legal thresholds (European Commission, 2017).

(EAC), while socially responsible award criteria (SRAC) is associated with fewer bids, particularly for instances with above median bids and contracts for works and for products and equipment. On the other hand, we generally see no significant relationships between the use of sustainable criteria and rebates. However, drawing causal conclusions from these relationships would be erroneous, as contracting authorities choose when to include sustainable criteria, potentially introducing endogeneity[7].

To address this concern, we leverage the 2014 change in the EU Directive on Public Procurement in Spain, which led to a substantial uptick in the adoption of SAC. Notably, this regulatory change may have prompted contracting agencies to incorporate SAC in cases where they previously would not have done so. We substantiate this idea with empirical evidence, revealing distinct patterns in contracts that -contrary to expectations- incorporated sustainable criteria.

We incorporate these dynamics by centering our analysis on post-regulatory-change contracts, and employing an inverse probability weighting based on how agencies had integrated sustainable criteria before the regulatory change. Our analysis unveils a negative impact of SAC on the number of received bids, evident in both EAC (-5.6%) and SRAC (-8.3%). These results evidence a substantial adverse effect of adopting sustainable criteria on the number of received bids. Moreover, we find that the use of EAC led to a decrease in rebates of 1 percentage point (p.p.), while no significant impacts are observed for SRAC. We argue that, while this increase may appear modest, it should be interpreted as a lower-bound estimate of the actual cost impact of the measure.

This study makes the following contributions. Firstly, it documents how the 2014 EU Directive's implementation in Spain caused an uptick in SAC adoption. Secondly, it provides empirical evidence of the negative impact of the inclusion of SAC in public contracts on the number of bids they attract. Thirdly, it provides evidence of a lower bound of the cost increase linked to the implementation of EAC.

The remainder of this paper is structured as follows: Section 2 provides an overview of the literature and outlines the contributions of our analysis. Section 3 delves into the data utilized in this study. Section 4 expands on the significance of the 2014 EU Directive. Section 5 details the empirical methods employed. Section 6 unveils the study's findings, and finally, Section 7 offers a concluding perspective.

2. Literature Review

[7] For instance, agencies could be including SAC in more “attractive” contracts, and since “attractiveness” is not observed, this would bias our estimates if attractiveness were also correlated with our outcomes.

Sustainability has emerged as an issue of central interest, prompting governments to respond in various ways, including the introduction of regulations. There is a growing consensus that environmental regulations can be effective[8], while social regulation is generally more debated. Besides being able to achieve their intended goals, sustainability regulations should aim to strike a balance and minimize associated costs.[9]

Nested within this broader picture, it lays the discussion surrounding the use of SPP. Evidence of the effectiveness of SPP is mixed, and there are positive and negative examples. There is evidence of successful applications of GPP, such as Sweden's organic food policy (Lindstrom et al., 2020), a policy for the construction sector in California (Simcoe and Toffel, 2014) and a green procurement scheme to reduce CO2 emissions in the Netherlands (Rietbergen and Blok, 2013). Additionally, there is evidence of positive indirect effects associated with GPP, such as increased innovation (Krieger and Zipperer, 2022). On the other side, there is evidence suggesting that GPP can have a "weak effect" at best (Lundberg et al., 2015). In a similar vein, there are examples of desirable outcomes for SRPP, mainly from the US. For instance, Marion (2011) finds positive results for minority business enterprises, and Rosa (2020) highlights an increase in participation of disadvantaged business after the introduction of subcontracting requirements. However, there is also opposing evidence. For instance, Orser et al. (2019), conclude that the "Women-Owned Small Business" certification does not increase bid frequency or success.

The evidence about the costs of these measures is limited and mixed as well. Lundberg & Marklund (2013) propose an economic model to analyse the use of GPP and conclude that in general it is not cost-effective to achieve the intended goals. Some papers provide a cost impact assessment of specific cases, mainly from Nordic countries. Ekomatcentrum (2019) provides an assessment of the extra cost of an organic food program, Aldenius & Khan (2017) study the extra costs for sustainable buses, and Ystmark Bjerkan et al. (2019) focus on the extra costs of sustainability in ferry services. However, the heterogeneous nature of sustainable public procurement (SPP) means that the actual direct extra costs associated with it vary significantly depending on the specific context, making it challenging to extrapolate results. In addition, there could be other undesirable effects besides extra costs, like corruption. Chiappinelli (2020) shows how high enough auditing costs could cause benevolent policymakers to allow cost-padding. This latter insight is important because, if SPP has the potential to increase these auditing costs, then it could be affecting the set of incentives for corruption as well. A recent study analyses French contracts and concludes that, while it does not

[8] A recent study from the United States shows that environmental regulation has been the main reason behind the reduction in air pollution in the 1990-2008 period (Shapiro and Walker, 2018).
[9] For instance, it has been argued that environmental regulation can create an advantage for large firms, discourage entry and increase market concentration (Heyes, 2009).

seem that sustainable clauses are used as a tool for favouritism, the risk may be in the awarding method (Maréchal & Morand, 2022).

In this study, we pay special attention to the award criteria. Historically, winning firms were selected using price as the major (or only) indicator. More recently, the alternative of Most Economically Advantageous Tender award criteria, or MEAT has gained traction. MEAT is a method of selection that allows the contracting authority to award the contract based on characteristics of the tender submission other than just price, like quality or, closer to our interest, environmental and social aspects. When the MEAT criteria include social or environmental factors, we say that the contract implements SAC.

The use of SAC has been increasing (Grandia & Kruyen, 2020), and while there is recent evidence of associated positive impacts[10], its effectiveness is a subject of debate. One of the reasons for this is that, since SAC is often implemented through MEAT, the degree to which it becomes an important factor in determining the winner of the contract is not given. That is, it could still be the case that price is the main determining factor in explaining the winner. This is not a simple technicality, as recent evidence from Germany shows that tenders that included environmental award criteria only weighted that dimension by 5% on average (Kozuch et al., 2022), limiting the way in which they could affect firms' behavior. Even when the SAC component is significant, its effect is not certain. Rosa (2022), even warns about potential negative effects, showing evidence that instruments directly aimed at increasing supplier diversity through affirmative action could increase inequalities within the target disadvantaged group. There is also not a common consensus in terms of efficiency, as the costs associated SAC are not clear. However, a recent study from the United States found that discounts to bids made by suppliers that subcontract from a pool of disadvantaged firms had a limited effect on contract prices (Rosa, 2020). In this line, Chiappinelli & Seres (2021) propose a public auction model in which discounts to green technologies could even reduce prices.

Importantly, there are no studies utilizing the MEAT SAC information to address the effect of their implementation on the number of bids a contract attracts[11], or on contract costs. Evaluating these impacts is the primary goal of our analysis and will be the main contribution of this study.

The way a procurement contract is designed directly affects the set of participating firms (Hoekman & Tas, 2020). A key characteristic of its design is the type of award criteria that is being

[10] For instance, in terms of small businesses participation (Nemec et al., 2021) and innovation (Krieger & Zipperer, 2022).
[11] It is worth mentioning that the number of bids, should not be understood as a direct measure of contract competition. Indeed, assessing the potential concentration of a given contract is not straightforward (Albano, 2019). For instance, contracts can -and often are- subcontracted and firms can form temporary partnerships and bid together. Furthermore, it has been documented that subcontracting and temporary partnerships (TPs) are affected by the characteristics of the auction format (Branzoli & Decarolis, 2015), and that TPs could be desirable both from the public and firm side (Camboni et al., 2021).

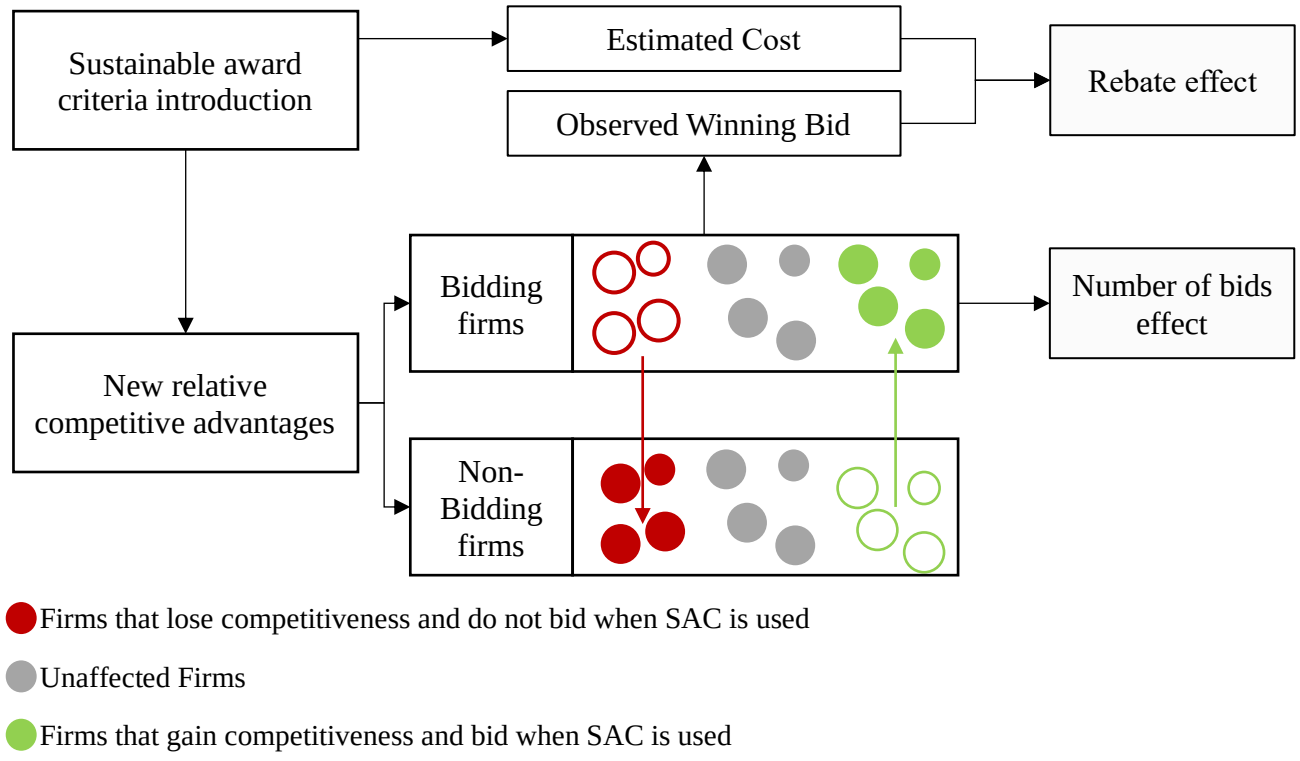
used to identify the winner. Therefore, it is likely that the introduction of SAC will affect firm participation, which it is closely related to competition and concentration. Moreover, fewer bids may even have an impact on corruption (Wachs et al., 2021).

However, the way SAC would affect firms' bidding behavior is not determined a priori. Recent evidence from Sweden shows that even in the case of hard environmental requirements (i.e. requirements needed to qualify as a bidder), their overall effect has been found to be non-significant on the number of bids (Drake et al., 2023). Moreover, the study finds that some specific environmental requirements are associated with more bids, while some other are associated with fewer bids.

There are various reasons why the effects on the number of bidding firms could also be not determined in the specific context of SAC. For instance, if the subset of firms capable of producing at the lowest price levels is different from the subset of firms endowed with the most sustainable technologies, then the sustainability criteria could reorder how competitive each firm is. This is because it would allocate importance to this -previously irrelevant to winning the contract- sustainability characteristic, hence improving the sustainable group of firms' chances. This means that the policy could turn formerly competitive firms into not competitive ones (so the number of bids could decrease), but also potentially turn once non-competitive firms into competitive players (so the number of bids could increase). The overall effect on the number of bidding firms is therefore unknown.

Moreover, the SAC introduction directly affects the estimated cost of the winning bid, as well as the observed winning bid, too. The overall effect on observed relative to estimated costs is thus unknown as well. Importantly, since observed prices are almost always below estimated prices, we can think of firms competing in the rebates -observed price- they offer with respect to the reserve price -estimated price- (see Figure 1).

Figure 1 – SAC: an undetermined effect



Source: author's own making

Furthermore, the type of firms that gain -or lose- competitiveness upon the introduction of SAC is not clear. A recent study from China shows that high-quality firms could refrain from bidding and low-quality firms could gain competitiveness, upon the introduction of quality award criteria, if the scoring rule is not specifically defined (Yao and Tanaka, 2020). Authors explain this phenomenon due to firms having to "guess" the desired quality, and high- and low-quality firms having distinct priors and commitments to it. This highlights how the introduction of an award criteria could have the opposite to the intended effect. While it is true that contracts that implement MEAT often display the chosen weighting criteria, the sustainability section is often vague and not in the form of a concrete threshold, which is analogous to the Chinese case. In such instances, sustainable firms might opt out of bidding when faced with SAC if their response to the policy would be prohibitively costly. On the other hand, less sustainability conscious firms might continue to bid and employ a low-price strategy, as their commitment to sustainability may not be as robust.

3. Data

Our main source is Tenders Electronic Daily (TED)[12] data for Spain. TED is the online version of the 'Supplement to the Official Journal' of the EU, dedicated to European public procurement. This

[12] https://ted.europa.eu/TED/main/HomePage.do

data is publicly available[13] and it has been used to study various topics, such as competition, small businesses participation, and corruption (Hoekman & Tas, 2020; Nemec et al. 2021; Wachs et al., 2021). TED provides extensive contract-level information across various dimensions. One of the most important available characteristics for this study is the number of bids each contract attracts. This will be our first outcome of interest and it will be key to analyse firm behavior changes associated with the use of SAC. Another important outcome to evaluate the performance of public contracts is the paid price. Particularly when it comes to sustainability regulations or instruments, extra costs are often a common concern. Unfortunately, no direct price analysis is possible using this data. This is because, although we count with the total value of the contract, we do not have any indication of quantity for most cases. Nonetheless, we do have, for a sub-sample of contracts[14], information on the official estimation of the contract cost made by the contracting authority. This estimation is made at the contract design stage, and it serves as a guide for firms to know what kind of bids are expected. In almost all cases, the estimation ends up being higher than the observed cost (Figure A.1 in the Annex). That is, in practice firms compete in the discounts, -or rebates- that they offer with respect to the estimated price -which could be understood as a reserve price-. The difference between estimated cost and observed cost, relative to the estimated cost will be our second outcome of interest. We will refer to this metric as the rebate of the contract: $\text{Rebate} = \frac{\text{EstimatedCost} - \text{ObservedCost}}{\text{EstimatedCost}}$. Increases in this metric imply that discounts increase. Conversely, negative changes imply that discounts decrease. Extrapolating any found rebate effects into cost effects is not straightforward. This is because SAC can potentially affect both the observed and estimated costs. However, if we make the reasonable assumption that adding extra sustainability dimensions to contracts cannot negatively affect the cost estimation made by contracting authorities, then any discount reduction will be a lower bound of cost increase effects. The opposite is not true. We cannot directly relate discount increases to cost decrease effects (unless we assume contracting authorities cannot increase their cost estimation to accommodate for the use of SAC).

TED offers 262 thousand contract award notices from 2011 and until 2019[15] for Spain. However, information is missing from many contracts. This means that the universe of studied contracts in the number of offers analysis will be of around 152 thousand and, in the case of the discounts analysis, around 86 thousand. We also have information about important covariates. The

[13] https://data.europa.eu/data/datasets/ted-csv?locale=en

[14] Not all contracts provide the estimated cost. Moreover, in some instances where the contract was divided into multiple winners there is a mismatch between total contract cost and firm-specific cost. That is, the cost estimation was made for the total cost of the contract and the observed winning price refers to the cost of a specific winner (or vice-versa). This error causes abnormally low -or high- ratios between observed and estimated costs. For this reason, we only consider cases where observed costs are between half and double the estimated cost, leaving out cases with multiple winners where there is a mismatch between overall and specific cost (a quarter of the cases).

[15] While 2020 data is available, it was excluded because of the COVID-19 pandemic.

date of the contract, object of the contract, type and activity of the contracting authority, total cost of the contract, number of lots the contract was divided into, type of procedure of the contract, whether the contract was part of the Government Procurement Agreement[16] , whether the contract implemented lowest price or MEAT (not necessarily related to sustainability), and a text description of the award criteria.

Table 1 below provides a summary of the outcomes and covariates used. Complete details on each specific variable are publicly available online[17].

Table 1 Summary of main outcomes and covariates

Variable	Description
Number of offers	The number of firms that present a bid to win each contract
Rebates	(Estimated cost- Observed cost) / Estimated cost
Date	Date of the contract
Main CPV	The 2-digit Common Procurement Vocabulary code of the main object of the contract[18]
Main Activity	COFOG divisions for the activity of the contracting authority[19]
Estimated cost	Estimated contract value, in EURO
Observed cost	Observed contract value, in EURO
Number of lots	Number of lots the contract was divided into
Type of CAE	Type of Contracting Agency.[20]
GPA	Dummy variable: 1 if the contract is part of the Government Procurement Agreement
Type of procedure	COD "competitive dialogue" NEC/NEG "negotiated with a call for competition" OPE "open" RES "restricted" INP "innovative partnership"
Award Criteria	MEAT; Lowest Price; No info

TED does not provide an indicator about whether each contract used SRAC or EAC directly, but we can indirectly obtain this information ourselves through the award criteria information. This variable specifies which factors were considered to select the winner of the contract. Among those, environmental or social ones could be included. We develop two dictionaries (one for SRAC and one for EAC) to identify cases of SAC in the award criteria, following Krieger and Zipperer (2022). If the award criteria mention a word from our dictionary, the contract is flagged as sustainable (either SRAC, EAC or SAC in the case of contracts that mention keywords from both dictionaries).

[16] The GPA is a plurilateral agreement within the WTO that aims to open government procurement markets among its parties. See https://www.wto.org/english/tratop_e/gproc_e/gp_gpa_e.htm
[17] https://data.europa.eu/euodp/en/data/storage/f/2022-02-14T122429/TED%28csv%29_data_information_v3.4.pdf
[18] See Table A.1 in the Annex for details.
[19] COFOG stands for Classifications of the Functions of the Government. See Table A.2 in the Annex for details.
[20] See Table A.3 in the Annex for details.

Table 2 provides a summary of the SRAC and EAC variables and how they were constructed. As we can see, unsurprisingly, the SRAC indicator is dominated by the "social" and "ethics" keywords, while the EAC indicator is dominated by the "environmental" keywords.

Table 2 Dictionaries for SRAC and EAC

	Keyword	Contracts	% of each SAC	% of Total
SRAC	Social	1579	61.7	1.03
	Ethics	935	36.54	0.61
	Woman	194	7.58	0.13
	Gender	68	2.66	0.04
	Opportunity	29	1.13	0.02
	Total SRAC (criteria can include more than one keyword)	2559		1.68
EAC	Environment	3649	70.21	2.39
	Energy	887	17.07	0.58
	Ecology	460	8.85	0.30
	Emissions	340	6.54	0.22
	Recycling	58	1.12	0.04
	Green	57	1.1	0.04
	Noise	43	0.83	0.03
	CO2	7	0.13	0.00
	Total EAC (criteria can include more than one keyword)	5197		3.40
SAC	Total SAC (either SRAC, EAC, or both)	6677		4.37

Note: keywords were translated from Spanish for reference. The absolute number refers to the number of contracts that showed the keyword. The percentage refers to the percentage of contracts classified as SRAC or EAC that had that specific keyword. Note that the total for SRAC and EAC is not the sum of contracts with each keyword, given that each contract can (and often do) contain more than one. Same applies for SAC.

Table 3 below shows a summary of descriptive statistics. We can observe that the average contract, the average contract with SRAC and the average contract with EAC, differ in the number of offers they get and in the rebates firms offer on average. SAC contracts have less offers in general, and the rebate is larger, compared to the average contract. This is especially true for SRAC contracts. When we distinguish between pre and post implementation of the 2014 EU Directive on Public Procurement, a crucial regulatory change in which we will expand in subsequent sections, we find further interesting dynamics. Prior to the regulatory change implementation, we can see that SAC

contracts had more offers and smaller rebates. Both for EAC and SRAC contracts, the number of bids decreased and rebates grew after the change in the regulation.

This is simply a first look into the data. Multiple facts could be playing a role in explaining the above differences: the activity of the CAs, objective of the contract, type of procedure, etc. We will look in more detail at the difference between normal, SRAC and EAC contracts in the subsequent sections.

Table 3 Summary statistics

		All		Pre		Post	
		Number of Offers	Rebates	Number of Offers	Rebates	Number of Offers	Rebates
SAC	Mean	6,75	0,13	9,53	0,11	5,91	0,13
	SD	7,71	0,15	11,01	0,14	6,15	0,15
	OBS	6677	4229	1542	1074	5135	3155
SRAC	Mean	5,31	0,13	6,75	0,11	5,02	0,13
	SD	6,35	0,15	11,71	0,16	4,54	0,15
	OBS	2559	1660	425	285	2134	1375
EAC	Mean	7,45	0,13	10,17	0,12	6,49	0,13
	SD	8,41	0,14	11,51	0,14	6,75	0,15
	OBS	5197	3324	1355	945	3842	2379
All	Mean	7,82	0,10	8,18	0,09	7,62	0,11
	SD	15,86	0,15	11,86	0,15	17,72	0,15
	OBS	152650	86987	55151	33824	97499	53163

4. The 2014 EU Directive on Public Procurement

The EU Directive on Public Procurement establishes its framework in the European Union (EU). It aims to ensure that public procurement processes in EU member states are transparent, non-discriminatory, and fair, and that they provide equal opportunities for all potential bidders.

The Directive applies to all types of public procurement, including the procurement of goods, works, and services by public authorities and utilities, as well as the awarding of public contracts. It sets out rules on how public contracts should be advertised, how bids should be evaluated, and how contracts should be awarded.

The Directive has been recently revised in 2014[21]. The 2014 revision of the Directive came with a greater focus on sustainability: it includes provisions on the use of social and environmental criteria in the award of contracts, with the aim of promoting sustainable public procurement.

When the EU adopts a directive, member states are required to transpose it into their national laws within a specified period. The process of transposition involves various steps, including review

[21] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0024

and analysis of the directive, drafting the necessary legislative changes and consulting with stakeholders, such as public authorities, businesses, and civil society organizations, and adoption and implementation of the required changes.

For these reasons, in Spain, the 2014 revision of the EU Directive on Public Procurement was transposed into national law a few years later, through the adoption of Law 9/2017[22], which was implemented in 2017.

As a first stage of our analysis, we test whether these regulatory changes influenced the utilization of SAC in Spain. To do this, we run an event study as descripted by the following equation:

$$Probability(SAC)_c = \beta * Year_c + X_c + e_c \quad (1)$$

Where $Probability(SAC)_c$ is a probit model for the utilization of each sustainability award criteria (SAC) where the unit of observation is the contract. We run this model three times, one for the probability of SAC, another one for SRAC and one for EAC. We include year dummy variables, and we use 2014 as our baseline. We further include an X_c vector of characteristics for each contract as covariates. This vector includes the total cost of the contract, the number of lots it was divided into, whether it included an award criterion (which can be non-sustainability related), the activity of the contracting authority, the object of the contract, whether the contract was covered by the General Procurement Agreement, the type of procedure, and a constant term.

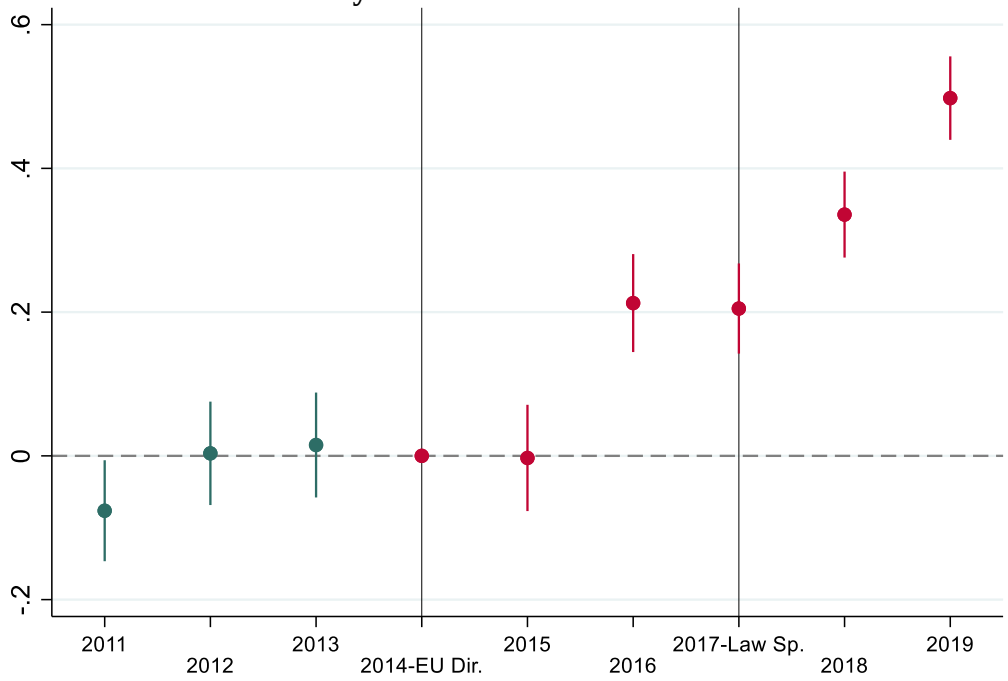
We can observe a stark increase in the year-effect on the probability of using SAC after the changes in the legislation, starting in 2016, one year before of the official implementation of the revision in Spain (Figure 2). The effect taking place one year before the official implementation is explained by the fact that the specifics of the revision were already available to contracting authorities. In particular, the fact the new regulatory framework was intended as a "soft" incentive to sustainability[23]. This dynamic is the same if we analyse the probability of including SRAC or EAC (Figure A.1 and A.2 in the Annex). Guided by the significant effect observed starting from 2016, we will use this date to mark the start of the "post" period in subsequent analysis[24]. The significant increase in the use of SAC in all its forms is an important change in contract design associated with the change in the legislation. This change might have had relevant correlates in the performance indicators of these latter notices, such as attracted number of bids and contract costs. In the following sections we will address this possibility.

[22] https://www.boe.es/buscar/pdf/2017/BOE-A-2017-12902-consolidado.pdf

[23] Before the revision, contracting authorities were allowed to include sustainability-related factors in the award criteria, but the correct practices were not clear. The revision acted as a "soft" encouragement to the utilization of sustainability criteria by explaining precisely what the "link to the subject matter of the contract" was, as well as giving examples of "sustainable" award criteria in Art. 67 of the new EU Directive.

[24] Our main results are maintained when we conduct robustness checks utilizing the official law implementation date.

Figure 2 –SAC Probit event study



Note: probit event study model for the use of sustainable award criteria controlling for observable characteristics of the contract. Each coefficient in the plot corresponds to each year fixed effect.

5. Methods

In this section we will outline the methods used to assess the impacts of SAC. Our approach is structured around three main parts. Initially, we conduct a descriptive analysis. Next, we evaluate various heterogeneous effects, including before and after a key regulatory change. Finally, we account for unlikely cases of SAC inclusion after the regulatory change to mitigate endogeneity.

Our first specification is the ordinary least squares (OLS), controlling for covariates. This specification does not account for endogeneity.

$$Outcome_c = \beta * AC_c + X_c + e_c \quad (2)$$

where $Outcome_c$ is either the absolute number of offers a contract attracts, its logarithm, or the rebates. AC_c is a dummy variable equaling one when the contract includes the sustainable award criteria (SAC, SRAC, or EAC). We further include an X_c vector of characteristics for each contract as covariates. This vector includes the total cost of the contract, the number of lots it was divided into, a fixed effect for the year of the contract, whether it included an award criterion (which can be non-sustainability related), the activity of the contracting authority, the type of contracting authority, the object of the contract, whether the contract was covered by the General Procurement Agreement, the type of procedure and a constant term.

In this model, β estimates the impact in absolute terms if the number of bids is used as the outcome, approximates a percentage change when the outcome is the logarithm of the number of bids, and it estimates a percentage point impact if the outcome is the rebate. The interpretation of the coefficients is the same throughout all models.

To address heterogeneous effects, we also run the previous model but restricting the database to above and below the median number of observed bids, above and below the median value of the contract, type of contracting authority, the most prominent activities for contracting authorities, whether a product, work or a service is being procured, and pre-post implementation of the 2014 EU Directive in Spain.

All the previous models do not account for endogeneity. This could be a major issue in this context, given that contracting authorities are choosing the contracts for which they include SAC. With the objective of alleviating this concern, we further explore one more heterogeneity, unlikely cases of AC inclusion after the regulation change. We restrict treated units to post-Directive implementation contracts that included sustainable AC, notwithstanding our predictive model was classifying them as "unlikely" contracts. The idea behind this exercise is to focus on the contracts that that were "pushed" to include each AC.

To that purpose, we first must predict whether each contract in our sample has SAC, SRAC or EAC. We run a probit model including pre-Directive implementation contracts only:

$$Probability\left(AC_{c\_pre}\right)_{c\_pre} = \beta * X_{c\_pre} + e_{c\_pre} \quad (3)$$

where $Probability\left(AC_{c\_pre}\right)_{c\_pre}$ is the probability that a pre-Directive-implementation contract is including either SAC, SRAC or EAC. X_{c_pre} is the vector of observable characteristics for those contracts. We only include pre-Directive implementation contracts so that the prediction will not be affected by the new practices after the regulatory change. Using the coefficients obtained from this model, we predict whether each contract will include SAC, SRAC or EAC for all the dataset (including post-Directive implementation contracts).

With the predicted AC inclusion likelihood, we construct $UnlikelyAC_c$, equaling one in the "unlikely" cases of each AC inclusion after the implementation of the Directive, zero otherwise:

$$UnlikelyAC_c \begin{cases} 1 & if \;\; AC_c = 1 \;\; ; \; Prob_{c_{pre}}(AC_c \,/X_c) \leq Threshold \;\; and \;\; Post_c = 1 \\ 0 & otherwise \end{cases} \quad (4)$$

where $Prob_{c_{pre}}(AC_c \,/X_c)$, is the probability of each contract having SRAC, EAC or SAC, computed exploiting the coefficients of the pre-Directive-implementation model. $Threshold$ is an exogenous parameter that indicates how low the prediction will have to be for the contract to be

considered "unlikely". $Post_c$ is a dummy equaling one for the treated period. In other words, the $UnlikelyAC_c$ dummy captures the contracts that, against our predictions, are including the sustainable award criteria after the change in the law.

Using this new explanatory variable, we run the following OLS specification, again controlling for covariates:

$$Outcome_c = \beta * UnlikelyAC_c + X_c + e_c \quad (5)$$

where $Outcome_c$ is either the absolute number of offers a contract attracts, its logarithm, or the rebates, and X_c represents the same vector of contract characteristics used before. Specification 5 includes post-Directive-implementation contracts only, and it drops those contracts that included the respective AC but are above $Threshold$ (i.e. the "likely cases" of SAC).

This exercise depends on the $Threshold$ parameter for selecting the "unlikely" cases. We group the likelihood predictions according to their 10 quantiles. In the extreme, choosing 0 as a threshold will result in no unlikely contracts identified, while choosing 10 as a threshold will identify all post-Directive contracts that included the AC. We will show the estimated effects for all possible thresholds to evaluate distinct dynamics between sub-samples with different likelihood levels.

After testing the heterogeneous impacts for different likelihood of AC inclusion levels, we run our final specification, an inverse probability weighted (IPW) model based on the pre-Directive-implementation predictions. The IPW approach assigns a higher importance to unlikely SAC contracts and unlikely non-SAC contracts, improving comparability. The IPW model utilizes all the identified contracts but assigns the following weights:

$$Weight_c = \begin{cases} 1/Prob_{c_{pre}}(AC_c\ /X_c) & if\ \ AC_c = 1 \\ 1/(1 - \ Prob_{c_{pre}}(AC_c\ /X_c)) & if\ \ AC_c = 0 \end{cases} \quad (6)$$

where $Weight_c$ is the weight each contract will have in this final specification, and $Prob_{c_{pre}}(AC_c\ /X_c)$ is the predicted probability of the contract including the studied award criteria, based on the probit model including pre-Directive implementation contracts only. We will run this specification for the pre-Directive-implementation sub-sample, as well as for the post-Directive-implementation sub-sample.

6. Results

6.1 Simple OLS specification

In this section we will present the main results of the study. To start, we show the estimates from the simple OLS specification detailed in equation (2) in Table 4 below. These are the estimates

from the model that does not account for effects not captured by the set of available contract characteristics[25].

Table 4 – Simple OLS results.

		All observations			Excluding top 1%		
	Outcome	**Log(Bids)**	**Bids number**	**Rebates**	**Log(Bids)**	**Bids number**	**Rebates**
SAC	$\widehat{\boldsymbol{\beta}}$	0.046***	-0.190	0.001	0.067***	0.073	0.000
	SE	(0.012)	(0.171)	(0.002)	(0.012)	(0.102)	(0.002)
	Obs.	152650	152650	86987	151100	151100	75290
	R2	0,22	0,31	0,11	0,21	0,18	0,11
SRAC	$\widehat{\boldsymbol{\beta}}$	-0.083***	-2.231***	-0.004	-0.044**	-1.054***	-0.001
	SE	(0.019)	(0.267)	(0.004)	(0.019)	(0.159)	(0.004)
	Obs.	152650	152650	86987	151100	151100	75290
	R2	0,22	0,31	0,11	0,21	0,18	0,11
EAC	$\widehat{\boldsymbol{\beta}}$	0.114***	0.841***	0.003	0.123***	0.652***	0.002
	SE	(0.014)	(0.191)	(0.003)	(0.013)	(0.114)	(0.003)
	Obs.	152650	152650	86987	151100	151100	75290
	R2	0,22	0,31	0,11	0,21	0,18	0,11

*** p<0.01, ** p<0.05, * p<0.1

If we include all observations, there is a mirrored and opposite effect for SRAC and EAC. While SRAC is associated with 8% fewer bids, EAC is associated with 11% more bids. Although these estimates are susceptible to confounding factors, this difference is telling. When it comes to rebates, we see non-significant coefficients. Notably, the estimated effect of SAC as a whole on the logarithm of the number of bids is positive, while it is non-significant but negative when using the number of bids as outcome. This difference is explained because the distribution of the number of bids has a long right tail, hence it is dominated by extreme values[26].

To alleviate this issue, we exclude the contracts with the top one percent number of offers and we present the results in the second set of results. As we can see, the direction of the estimates is now robust for models using the number of bids and its natural logarithm as outcomes. Overall, SAC contracts show 7% more bids. This effect is composed by a negative 4% effect in the case of SRAC contracts, and a positive 12% effect in the case of EAC contracts. The same qualitative result is maintained: we observe a positive relationship between the use of EAC and the number of bids, and a negative relationship between the use of SRAC and the number of bids, while no significant discount effects are identified.

[25] The number of bids a contract attracts is restricted to positive numbers only. For this reason, we are also replicating all analysis with a TOBIT specification. The differences between the OLS and TOBIT specifications are negligible, so for simplicity we do not include the TOBIT estimates in the tables. For more information on the nature of the TOBIT specification see Amemiya (1984).

[26] See Cameron & Trivedi (2010) for further explanation and examples.

In section 6.2 below we further inspect these findings and disaggregate the effect by restricting the studied sample in various ways. In all cases from now on, we exclude the contracts with the top one percent number of offers[27].

6.2 **Heterogeneities**

The results presented in the preceding section highlight distinct patterns for contracts that utilise SRAC and EAC. These findings prompt a more comprehensive investigation into the diverse effects associated with the inclusion of SAC.

In this section, we delve deeper into various sub-sections of the data. Specifically, we partition the sample according to the median number of bids and the median contract value, comparing the estimates for above and below sub-groups. Furthermore, we explore potential heterogeneous effects at different institutional levels of contracting authorities: federal agencies and regional agencies[28]. In addition, we inspect how the activity of the agency could be related to different impacts, by isolating the most prominent activities (health and education[29]). Moreover, we analyse distinct patterns in the estimates in contracts for the purchase of products, services, or works. Finally, we study the sub-sample of contracts awarded before and after the implementation of the 2014 EU Directive in Spain. Results are presented in Table 5.

In general, we find positive relationships between the use of SAC and the number of bids across the studied sub-samples. While EAC is generally associated with more bids, the effect of SRAC is negative for most sub-groups, particularly for contracts with above median bids and contracts for works and for products and equipment.

Regarding the impacts of SAC on rebates, even though the picture is not as clear, we can still draw some conclusions. While many estimates are non-significant, they consistently show positive impacts, that is, rebates grow. In fact, in the case of contracts by agencies employed in the two most common activities -health and education-, the effects of SAC, EAC and SRAC are positive and mostly significant. Similar dynamics can be found among contracts for products and equipment. These identified impacts imply between 1p.p. and 2p.p. larger discounts with respect to a baseline 10% discount to the estimated price. As it was discussed before, these rebate increases provide no direct implication for costs' impacts.

[27] This means that we will include contracts with 1 to 65 bids and exclude the rest. Nonetheless, all presented results are qualitatively maintained if we do not exclude the top one percent.
[28] Note that a significant part of the contracting authorities was not categorized in either one. See table A.3 for details.
[29] The top 2 categories of contracting authorities by the number of awarded contracts that are identified. See table A.2 for details.

Another interesting result comes from analysis by the government level of the agency. Among federal contracting authorities, we see a distinct behavior: SAC are associated with 15% fewer bids, and this is mainly driven by EAC. A potential cause for this could be that federal agencies may have less information about the capabilities of local firms, hence possibly introducing unrealistic criteria into the tenders. Moreover, this impact is not present among regional agencies, which is consistent with this explanation, as they would have a clearer picture about how capable local firms are, hence designing the criteria in a smarter and more achievable way.

Another exception pertains to the estimates before and after the implementation of the 2014 EU Directive sub-samples. This is a specially interesting heterogeneity because, as we discussed in Section 4, there was a stark increase in SAC utilization after the regulation change (see Figure 2). Results reveal a substantial shift in the way SAC impacts contracts following the new regulation.

During the pre-implementation period, SAC estimates show a positive effect (+15%) in the number of bids. This is primarily driven by EAC, which is estimated to increase bids in 19%. On the other hand, SRAC is associated with fewer bids, but the effect is not statistically significant.

Interestingly, the scenario changes after the implementation of the 2014 Directive. The overall effect for SAC remains positive but decreases substantially to around 4%. This is explained by the much lower positive estimates for EAC, which stand at approximately 9%. For SRAC, a negative and non-significant effect is observed. We identify no significant discount effects in neither period.

When comparing the estimates from our model before and after the Directive's implementation, a clear trend emerges: the previously strong positive association between SAC and the number of received bids by each contract experiences a significant decline. This shift is explained by a reduction in the influence of EAC on the number of bids.

It is possible that with the new Directive's strong emphasis on social and environmental sustainability, agencies may have been induced to include SAC more broadly after its implementation. This dynamic may be playing a role in the observed reduction in the estimates of the effect of SAC on the number of attracted bids.

Table 5 – Heterogeneities

	SAC		EAC		SRAC	
	Log(Bids)	**Rebates**	**Log(Bids)**	**Rebates**	**Log(Bids)**	**Rebates**
Contracts up to the median in N. of Offers	0.028***	0.003	0.029***	0.010***	0.006	-0.008
	(0.009)	(0.003)	(0.010)	(0.004)	(0.013)	(0.005)
Contracts above the median in N. of Offers	0.004	-0.007*	0.052***	-0.009**	-0.088***	0.002
	(0.010)	(0.003)	(0.011)	(0.004)	(0.017)	(0.005)
Contracts up to the median value	0.063***	0.001	0.113***	0.003	-0.048	-0.003
	(0.019)	(0.004)	(0.021)	(0.004)	(0.029)	(0.006)
Contracts above the median value	0.090***	-0.002	0.140***	0.000	0.007	-0.001
	(0.015)	(0.003)	(0.017)	(0.003)	(0.023)	(0.005)
Contracts from Federal CAEs	-0.151***	0.002	-0.165***	-0.001	-0.014	0.036**
	(0.037)	(0.007)	(0.038)	(0.007)	(0.085)	(0.016)
Contracts from Regional CAEs	0.061***	0.002	0.115***	0.005	0.011	-0.003
	(0.016)	(0.003)	(0.019)	(0.004)	(0.024)	(0.005)
Contracts for Products and Equipment	0.103***	0.011***	0.145***	0.010**	-0.075**	0.018***
	(0.020)	(0.004)	(0.022)	(0.004)	(0.035)	(0.006)
Contracts for Services	0.048***	-0.005	0.118***	0.000	-0.023	-0.013***
	(0.015)	(0.003)	(0.017)	(0.004)	(0.021)	(0.005)
Contracts for Works	0.110**	-0.005	0.155***	-0.007	-0.168*	-0.007
	(0.048)	(0.009)	(0.049)	(0.009)	(0.089)	(0.019)
Health contracting authorities	0.310***	0.015**	0.369***	0.004	-0.060	0.020*
	(0.033)	(0.007)	(0.037)	(0.008)	(0.063)	(0.011)
Education contracting authorities	-0.005	0.018**	0.083**	0.017**	-0.165***	0.022**
	(0.038)	(0.007)	(0.042)	(0.008)	(0.060)	(0.011)
Pre-Law Implementation	0.152***	-0.004	0.188***	-0.001	-0.055	-0.000
	(0.024)	(0.005)	(0.026)	(0.005)	(0.045)	(0.009)
Post-Law Implementation	0.040***	0.001	0.092***	0.003	-0.027	-0.001
	(0.013)	(0.003)	(0.015)	(0.003)	(0.020)	(0.004)

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

6.3 Unlikely cases of Sustainable Award Criteria

As it was mentioned in the previous section, following the regulation change, the positive impact of SAC on the number of received bids was reduced. Potentially, this effect was caused by

more contracts being exogenously induced to include some form of SAC. In this section, we will further expand on this analysis by focusing on the unlikely cases of SAC introduction following the new Directive's implementation[30]. As explained in section 5, what constitutes an unlikely SAC contract will depend on the chosen threshold. Figure 3 shows the estimation using all the ten quantiles of the prediction as thresholds. The upper coloured bars represent the estimated effect of unlikely SAC for each threshold[31], while the lower-white bars represent how many contracts are being identified as "unlikely" under each threshold.

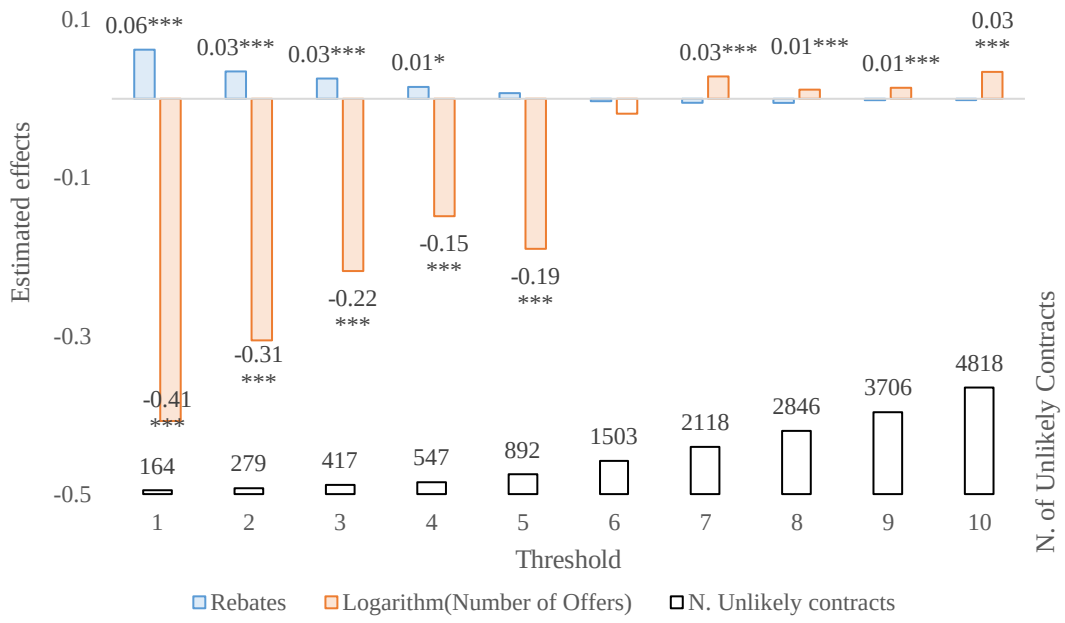
When we set the highest threshold (all cases of SAC under the 10th and maximum quantile of predicted likelihood), we observe approximately the same coefficients reported in the post-Directive-implementation model of Table 5 above. This is expected, as the "unlikely" restriction becomes non-binding at this point. On the opposite site, when we set the threshold to the lowest quantiles, we see strong negative effects in the number of bids, and positive impacts in rebates. For all in-between cases, we observe that the more we restrict the studied contracts by lower thresholds of likelihood, the more we move in each extreme case direction.

We then repeat this same exercise but looking at SRAC and EAC separately. Figure 4 reports the estimates for the contracts that utilize SRAC. Even if the significance is lost for many sub-samples, the negative effect on the number of bids is present in almost all sub-samples. This was expected and is in line with the specifications presented in previous sub-sections. When it comes to the discounts, we see a similar story to what we observed in the SAC figure: the more unlikely the sub-sample analysed, the more positive the effect on rebates.

In Figure 5, we observe the estimates for the contracts that utilize EAC. The effects on the number of bids are qualitatively identical to those explained for SAC: the more unlikely the sub-sample, the more negative the impact on the number of bids. When it comes to the discounts, instead, we find a difference. Although rebates' coefficients are mainly non-significant, they are mostly negative.

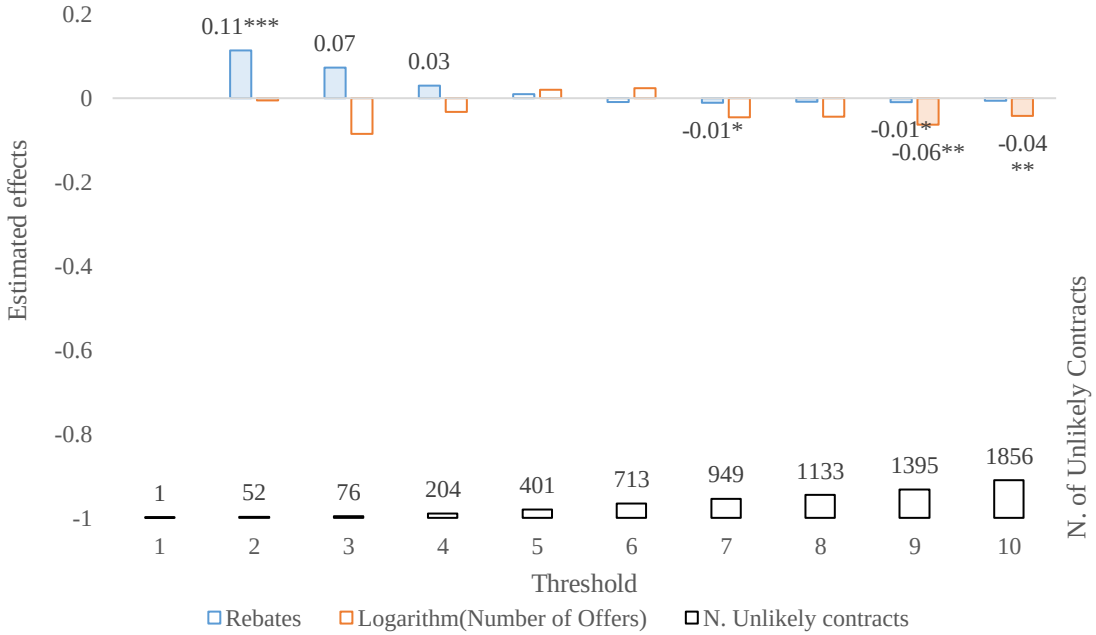
[30] As it was discussed in Section 4, for the main specifications we will use 2016 as the start of the "post" period. We replicate the analysis using 2017 as the starting of the post period in Figure A.4 and find qualitatively the same results.
[31] See equation 5.

Figure 3 – SAC effects for different likelihood thresholds



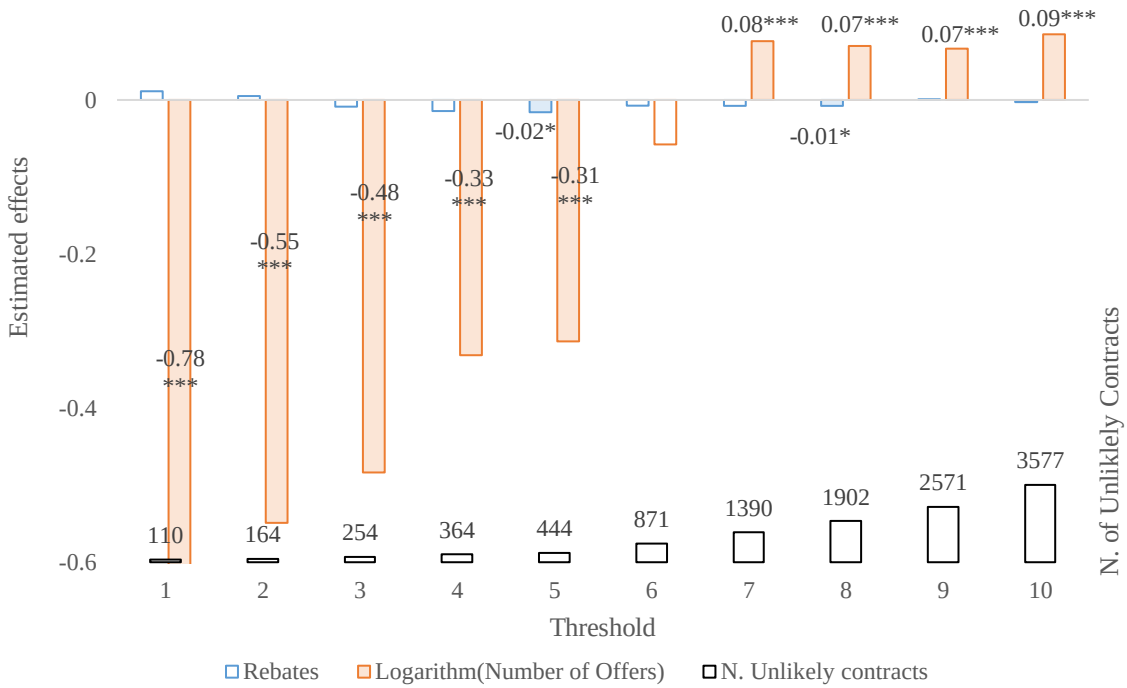
*Note: All models restricted to the post-Directive-Implementation period. The threshold represents the quantiles of the prediction. If, for example, threshold 7 is chosen, all contracts predicted to have a probability of SAC below the seventh quantile of predictions are included as "unlikely cases". **p<0.1, ** p<0.05, *** p<0.01.*

Figure 4 – SRAC effects for different likelihood thresholds



*Note: All models restricted to the post-Directive-Implementation period. The threshold represents the quantiles of the prediction. **p<0.1, ** p<0.05, *** p<0.01.*

Figure 5 – EAC effects for different likelihood thresholds



*Note: All models restricted to the post-Directive-Implementation period. The threshold represents the quantiles of the prediction. **p<0.1, ** p<0.05, *** p<0.01.*

After conducting these exercises, we can conclude that the more unlikely the introduction of SAC is, the more negative the estimated effect on the number of bids is. This effect is mainly driven by EAC contracts.

When it comes to the rebates, we again see that the more unlikely the introduction of SAC is, the more discounts grow. However, this time the effect is driven by SRAC contracts, while for EAC contracts we see, if anything, negative impacts on rebates.

If we accept our identifying assumption that contracts unlikely to utilize EAC and SRAC after the regulatory change are closer to be exogenously determined, then the estimations discussed in this section are quite telling. This analysis points at SAC, having a negative impact in the number of bids a contract attracts, and potentially heterogenous impacts in the discounts firms offer. In section 6.4 we will present and analyse our final specification, which takes these results into account.

6.4 Inverse Probability Weighting

Given the results discussed in the previous section, we would expect that the IPW specification, for the period after the regulation change (Post), would estimate a negative relationship between the use of sustainable award criteria and the number of bids a contract attracts. With respect

to the discounts, we would expect diverse effects for SRAC and EAC. Results are presented in Table 6[32].

Table 6. IPW Specification

		Pre			Post		
	Outcome	**Log(Bids)**	**Bids Number**	**Rebates**	**Log(Bids)**	**Bids Number**	**Rebates**
SAC	$\widehat{\boldsymbol{\beta}}$	0.139***	1.337***	-0.00468**	-0.0171*	-0.631***	0.00936***
	SE	(0.0102)	(0.101)	(0.00221)	(0.0100)	(0.0668)	(0.00275)
	Obs	32,530	32,530	15,777	50,419	50,419	27,736
EAC	$\widehat{\boldsymbol{\beta}}$	0.171***	1.533***	-0.00311	-0.0560***	-0.436***	-0.0105***
	SE	(0.0102)	(0.101)	(0.00223)	(0.00931)	(0.0667)	(0.00225)
	Obs	32,186	32,186	15,571	49,928	49,928	27,327
SRAC	$\widehat{\boldsymbol{\beta}}$	-0.466***	-3.851***	-0.00713***	-0.0826***	-1.596***	0.00662
	SE	(0.0112)	(0.102)	(0.00266)	(0.0147)	(0.0816)	(0.00552)
	Obs	28,415	28,415	13,490	43,801	43,801	23,976

**** p<0.01, ** p<0.05, * p<0.1*

After the implementation of the Directive, our IPW model reveals a negative association between the use of sustainable award criteria (both EAC and SRAC) and the number of bids a contract receives. To interpret these findings, we compare the IPW estimates before and after the regulatory change, as well as the post-regulation change estimations in both the IPW and standard models (Table 6, IPW results; Table 5, standard model results).

Regarding EAC, the IPW model estimates a negative effect for the post-period of approximately -5.6%, or 0.4 fewer bids. This contrasts with the positive estimates in both the IPW model for the pre-period (+17%), and the standard model for the post-period (+9%). This difference is explained by a distinct negative impact among unlikely contracts, which are the contracts "induced" to include EAC, according to our identification assumption.

For SRAC, the IPW model estimates a negative effect for the post-period, around 8.3% or 1.6 fewer bids. Interestingly, this effect is smaller than the pre-period IPW estimate (-47%), while the standard model did not identify a significant reduction in bids. This means that the IPW specification estimates a negative impact for SRAC; but that this impact existed, and it was stronger, before the

[32] This analysis is replicated in the Annex using 2017 as the start of the "post" period as a robustness check, confirming the results (Table A.4). The one difference comes from the SRAC estimate, which indicates that discounts grow in that model (and not a non-significant result as in our main specification). In any case, the EAC reduction in the discount is maintained, which is the only result that can be extrapolated as a lower bound of a cost increase.

regulatory change. A possible explanation for this dynamic could be a "learning effect", where contracting authorities improve SRAC design; and the private sector enhances its implementation, collectively mitigating negative effects over time.

In terms of the rebates, the IPW model estimates a positive impact for sustainable award criteria. However, in this case the results differ between EAC and SRAC. For this reason, we analyse each SAC type separately, and again compare the IPW estimates before and after the regulatory change, as well as the post-regulation change estimations in both the IPW and standard OLS models.

The IPW estimates for EAC in the post period show a small but negative and significant impact, which implies a decrease of 1p.p. with respect to the baseline discount of 11%. This means that the use of EAC led to an increase in observed relative to estimated costs. Importantly, this effect is not present neither when we look at the IPW estimates for the pre-period, nor when we look at the standard estimates for the post-period. This implies, according to our identification assumption, that the effect is driven by the contracts "induced" to include EAC. If we assume that the use of EAC did not cause contract cost estimations to decrease, then this is evidence of a lower bound of the cost increase effect.

For SRAC, the IPW estimates for the post-period are non-significant. The same is true as the standard OLS estimates for the same period; while before the regulation change, the IPW estimates were small but negative. That is, the IPW model shows a decrease in discounts during the pre-period; but this effect is small, and it disappears in the post-period. The explanation for this may also be related to the dynamic discussed for the SRAC impacts on the number of bids: enhanced design, and improved implementation mitigating negative effects.

7. Conclusion

Public procurement explains a large part of the economy. Given its size, governments are interested in accomplishing various objectives alongside the main purpose of what is being procured. One common such objective is sustainability. This practice is often called sustainable public procurement, and it is on the rise, particularly in Europe. Despite its growth, empirical evidence of the impacts of this practice on contract performance and firm behavior remains limited. In this study, we contribute to this gap in the literature by analysing the impact of a particular kind of sustainable public procurement -sustainable award criteria-, on the number of received bids, and on a measure of observed relative to estimated contract costs, akin to cost discounts or rebates.

For our analysis, we utilized data from Tenders Electronic Daily, the central database for public procurement notices in the European Union, covering the years 2011 to 2019 in Spain. An initial descriptive analysis shows positive associations between sustainable award criteria and the

number of received bids. This result is mainly driven by environmental award criteria, while contracts that included socially responsible award criteria, show a negative association. On the other hand, we generally see no significant relationships between the use of sustainable criteria and the discounts. Drawing causal conclusions from these relationships would be premature. This is because contracting authorities actively select the contracts for which they include the sustainable criteria, introducing endogeneity.

To mitigate this issue, we leverage the implementation of the European Union's Directive on Public Procurement in Spain, which brought about a significant increase in the adoption of sustainable award criteria. Notably, this regulatory change may have prompted contracting authorities to incorporate sustainable award criteria in cases where they previously would not have. We provide empirical evidence supporting this notion and show that contracts that incorporated sustainable criteria and were unlikely to do so, exhibit distinct dynamics.

Accounting for this differential impact, our final specification employs an inverse probability weighting method, according to how contracting agencies included sustainable criteria before the regulation change.

We unveil a negative effect in the number of attracted bids, which is present both in environmental award criteria (-5.6%) and socially responsible award criteria (-8.3%). There remains ample room for further research to provide contextualization and actionable policy recommendations surrounding this identified effect. First, research that focuses on whether this bidding reduction is explained by the most sustainable or the least sustainable firms is key, as recent studies have shown that quality bidders may refrain from bidding when vague award criteria is used. Moreover, a crucial unexplored aspect pertains to the role of sustainable award criteria in firm selection. If sustainable award criteria significantly improves the sustainability levels of the winning firm, then reduced bids may align with the contracting authority's goals. Conversely, if these criteria have limited influence on selection, bid reduction may represent a direct cost with uncertain benefits. Recent evidence could be pointing towards the latter scenario, but the debate continues.

In terms of rebates, we observe a negative impact associated with the use of environmental criteria (-1p.p. with respect to a baseline discount of 11%), while no significant impacts are found for socially responsible criteria. On one hand, these results suggest that the effects on percentage rebates are generally limited, with estimates consistently small and often non-significant. However, the positive and significant estimate for environmental criteria raises questions about cost effects. Although the increase may seem small, this is to be interpreted as a lower bound of the real cost impact of the measure. Further research that can directly assess cost impacts would provide valuable insights that complement the identified effects.

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Appendix

Table A.1 CPV 2-digit

CPV 2-Digit code	Description	Category	Freq.	Percent	Cum.
33	MEDICAL EQUIPMENTS, PHARMACEUTICALS AND PERSONAL CARE PRODUCTS	Equipment	34,821	22.81	22.81
90	SEWAGE-, REFUSE-, CLEANING-, AND ENVIRONMENTAL SERVICES	Services	11,773	7.71	30.52
50	REPAIR AND MAINTENANCE SERVICES	Services	10,871	7.12	37.64
60	TRANSPORT SERVICES (EXCL. WASTE TRANSPORT)	Services	5,887	3.86	41.5
79	BUSINESS SERVICES: LAW, MARKETING, CONSULTING, RECRUITMENT, PRINTING AND SECURITY	Services	7,319	4.79	46.3
72	IT SERVICES: CONSULTING, SOFTWARE DEVELOPMENT, INTERNET AND SUPPORT	Services	7,449	4.88	51.18
15	FOOD, BEVERAGES, TOBACCO AND RELATED PRODUCTS	Products	5,299	3.47	54.65
71	ARCHITECTURAL, CONSTRUCTION AND INSPECTION SERVICES	Services	5,756	3.77	58.42
45	CONSTRUCTION WORK	Works	4,506	2.95	61.37
85	HEALTH AND SOCIAL WORK SERVICES	Services	4,768	3.12	64.49
34	TRANSPORT EQUIPMENTS AND AUXILIARY PRODUCTS TO TRANSPORTATION	Equipment	4,785	3.13	67.63
39	FURNITURE (INCL. OFFICE FURNITURE), FURNISHINGS, DOMESTIC APPLIANCES (EXCL. LIGHTING) AND CLEANING PRODUCTS	Equipment	2,986	1.96	69.58

30	OFFICE AND COMPUTING MACHINERY, EQUIPMENT AND SUPPLIES EXCEPT FURNITURE AND SOFTWARE PACKAGES	Equipment	3,929	2.57	72.16
31	ELECTRICAL MACHINERY, APPARATUS, EQUIPMENTAND CONSUMABLES ; LIGHTING	Equipment	3,118	2.04	74.2
80	EDUCATION AND TRAINING SERVICES	Services	2,694	1.76	75.97
38	AGRICULTURAL MACHINERY	Equipment	3,227	2.11	78.08
44	Construction materials and auxiliary products to construction	Products	2,284	1.5	79.58
66	FINANCIAL AND INSURANCE SERVICES	Services	2,652	1.74	81.31
93	Utility Services: Electricity	Products	2,218	1.45	82.77
24	CHEMICAL PRODUCTS	Products	2,736	1.79	84.56
91	Utility Services Gas	Products	2,321	1.52	86.08
32	RADIO, TELEVISION, COMMUNICATION, TELECOMMUNICATION AND RELATED EQUIPMENT	Equipment	2,243	1.47	87.55
92	RECREATIONAL, CULTURAL AND SPORTING SERVICES	Services	1,966	1.29	88.84
64	POSTAL AND TELECOMMUNICATIONS SERVICES	Services	2,014	1.32	90.16
18	CLOTHING, FOOTWEAR, LUGGAGE ARTICLES AND ACCESSORIES	Products	1,588	1.04	91.2
55	HOTEL, RESTAURANT AND RETAIL TRADE SERVICES	Services	1,386	0.91	92.1
98	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	Services	1,341	0.88	92.98
48	Software package and information systems	Products	1,585	1.04	94.02
77	AGRICULTURAL, FORESTRY, HORTICULTURAL, AQUACULTURAL, APICULTURAL SERVICES	Services	1,445	0.95	94.97
42	INDUSTRIAL MACHINERY	Equipment	1,148	0.75	95.72
35	SECURITY, FIRE-FIGHTING, POLICE AND DEFENCE EQUIPMENT	Equipment	1,076	0.7	96.42
22	PRINTED MATTER AND RELATED PRODUCTS	Products	1,112	0.73	97.15
63	SUPPORTING AND AUXILIARY TRANSPORT SERVICES; TRAVEL AGENCIES SERVICES	Services	1,063	0.7	97.85
73	RESEARCH AND DEVELOPMENT SERVICES AND RELATED CONSULTANCY SERVICES	Services	592	0.39	98.24
14	MINING, BASIC METALS AND RELATED PRODUCTS	Products	546	0.36	98.59
75	ADMINISTRATION, DEFENCE AND SOCIAL SECURITY SERVICES	Services	417	0.27	98.87
65	PUBLIC UTILITIES	Works	561	0.37	99.23
37	MUSICAL INSTRUMENTS, SPORT GOODS, GAMES, TOYS, HANDICRAFT, ART MATERIALS AND ACCESSORIES	Products	313	0.21	99.44
51	INSTALLATION SERVICES (EXCEPT SOFTWARE)	Services	211	0.14	99.58
19	LEATHER AND TEXTILE FABRICS, PLASTIC AND RUBBER MATERIALS	Products	238	0.16	99.73
16	AGRICULTURAL MACHINERY	Equipment	122	0.08	99.81
43	MACHINERY FOR MINING, QUARRYING, CONSTRUCTION EQUIPMENT	Equipment	181	0.12	99.93
70	REAL ESTATE SERVICES	Services	55	0.04	99.97
41	COLLECTED AND PURIFIED WATER	Works	26	0.02	99.99
76	SERVICES RELATED TO THE OIL AND GAS INDUSTRY	Works	22	0.01	100

Note: The 2-digit Common Procurement Vocabulary code of the main object of the contract. Info obtained from https://simap.ted.europa.eu/documents/10184/36234/cpv_2008_explanatory_notes_en.pdf
** Sections 93 and 91 are not described in the cited resource. Exploring the contracts in our sample, I've found they're used to buy electricity and gas respectively.*

Table A.2 Activities

Activity	Frequency	Percentage	Cummulative
Health	42,747	28.0%	28.0%
General	38,584	25.3%	53.3%
Other	20,241	13.3%	66.5%
Education	13,466	8.8%	75.4%
Railway services	6,723	4.4%	79.8%
Environment	5,842	3.8%	83.6%
Eco anf Financial Affairs	5,109	3.4%	86.9%
Public Order and Safety	4,197	2.8%	89.7%
Social protection	3,426	2.2%	91.9%
Defence	2,988	2.0%	93.9%
Energy	2,250	1.5%	95.4%
Water	1,993	1.3%	96.7%
Airport	1,435	0.9%	97.6%
Recreation	1,131	0.7%	98.4%
Housing and community	943	0.6%	99.0%
Postal	913	0.6%	99.6%
Port	477	0.3%	99.9%
Production	185	0.1%	100.0%

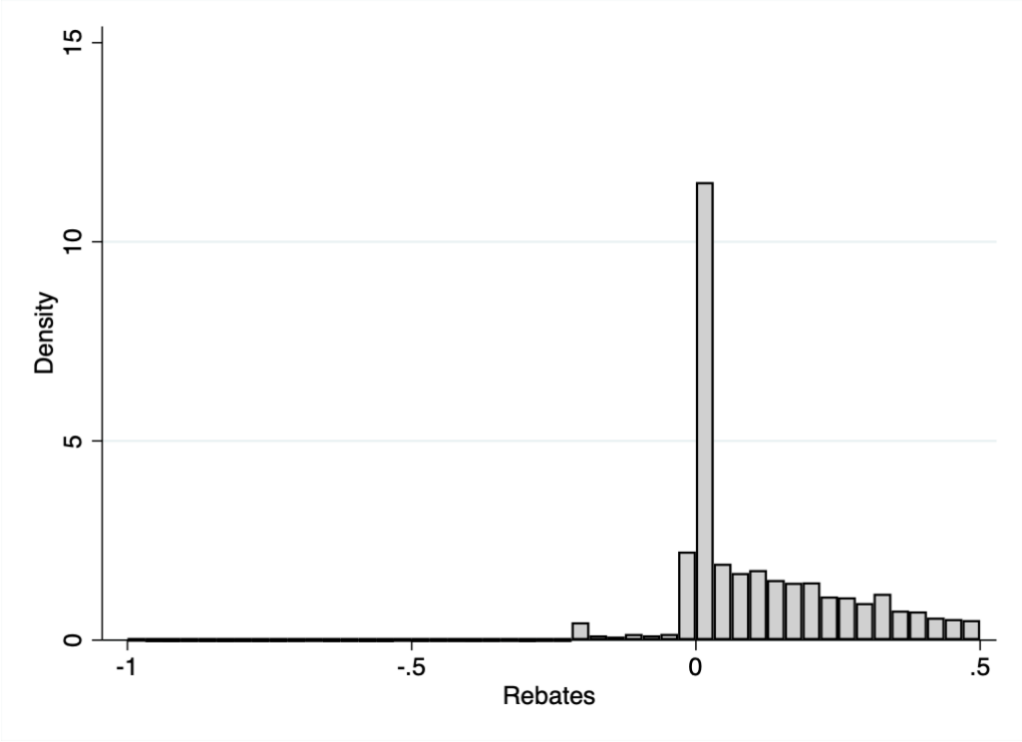
Note: In 90% of the cases, only 1 Main activity was mentioned. For the rest of the cases, the first main activity mentioned was used.

Table A.3 Type of contracting authority

CAE_TYPE	Definition	Category	Freq.	Percent	Cum.
3	Regional or local authority	Regional	60295	39.5%	39.5%
8	Other	Rest	27894	18.3%	57.8%
6	Body governed by public law	Federal	24916	16.3%	74.1%
4	Utilities	Rest	14699	9.6%	83.7%
1	Ministry or any other national or federal authority, including their regional or local subdivisions	Federal	14452	9.5%	93.2%
R	Regional or local agency / office	Regional	8551	5.6%	98.8%
Z	Not specified	Rest	781	0.5%	99.3%
5	European Union institution/agency	Rest	767	0.5%	99.8%
N	National or federal agency / Office	Rest	287	0.2%	100.0%
5A	Other international organisation	Rest	8	0.0%	100.0%

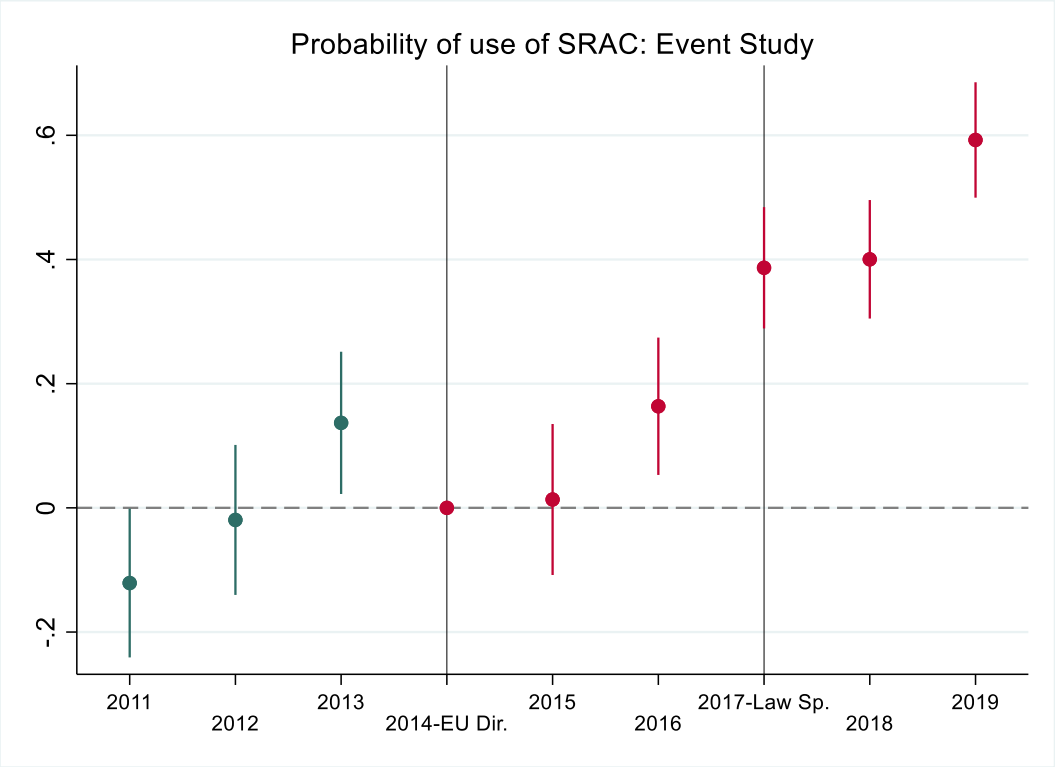
Note: Code definition obtained from https://data.europa.eu/euodp/en/data/storage/f/2022-02-14T122429/TED%28csv%29_data_information_v3.4.pdf

Figure A.1 – Rebates histogram



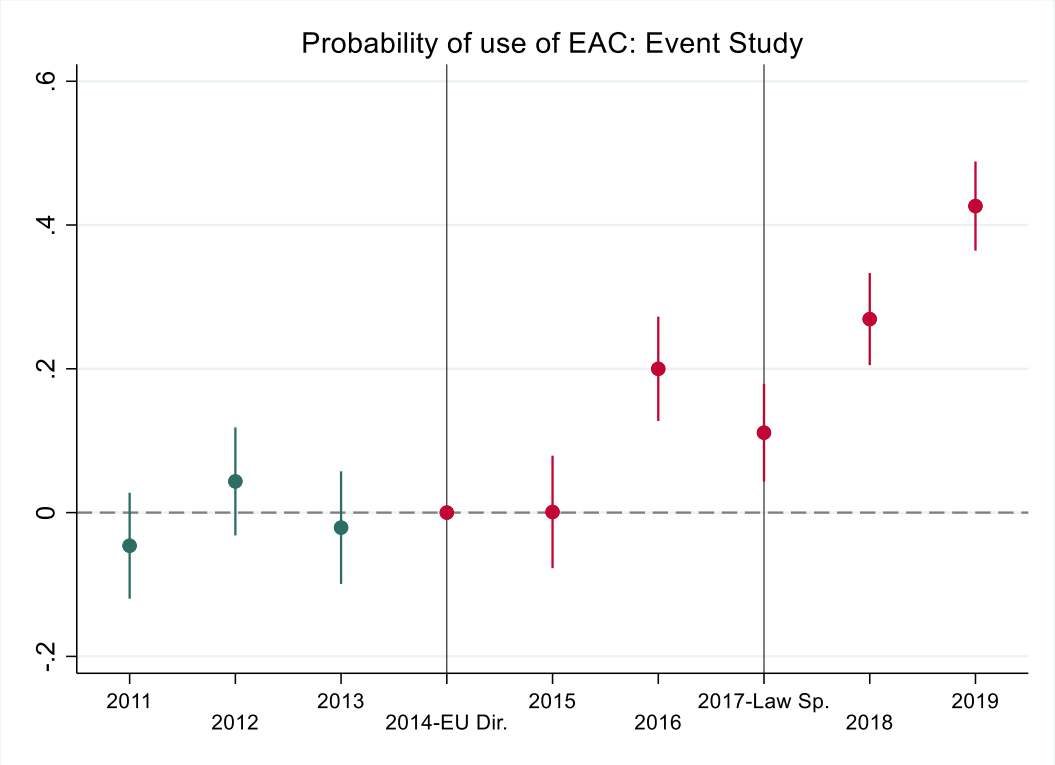
Note: $Rebates = \frac{Estimated\ Contract\ Cost - Observed\ Contract\ Cost}{Estimated\ Contract\ Cost}$

Figure A.2 – Probability of SRAC event study



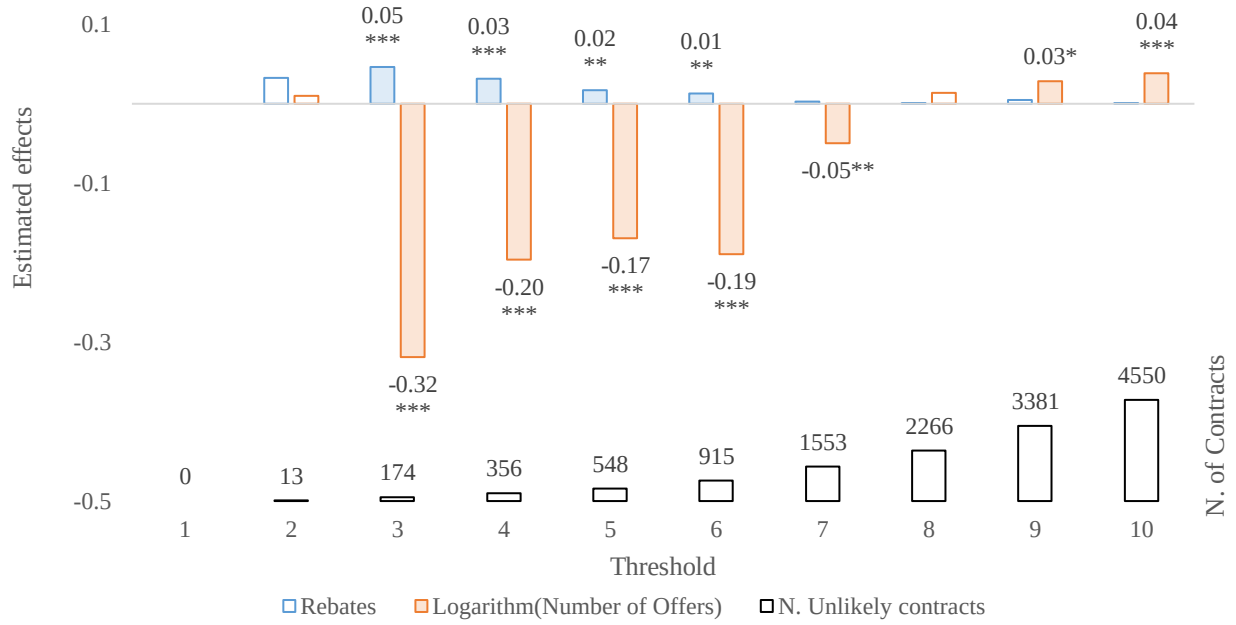
Note: probit event study model for the use of socially responsible award criteria controlling for observable characteristics of the contract.

Figure A.3 – Probability of EAC event study



Note: probit event study model for the use of environmental award criteria controlling for observable characteristics of the contract.

Figure A.4 – Unlikely SAC cases – 2017 Implementation



Note: All models restricted to the post-Directive-Implementation period.
The threshold represents the quantiles of the prediction.
If, for example, threshold 7 is chosen, all contracts predicted to have a probability of SAC below the seventh quantile of predictions are included as "unlikely cases".
**p<0.1, ** p<0.05, *** p<0.01.*

Table A.4. IPW Specification – 2017 implementation

		Pre			Post		
	Outcome	**Log(Bids)**	**Bids Number**	**Rebates**	**Log(Bids)**	**Bids Number**	**Rebates**
SAC	$\widehat{\boldsymbol{\beta}}$	0.173***	1.244***	-0.00542***	-0.0223*	-0.624***	0.00744***
	SE	(0.00865)	(0.0816)	(0.00199)	(0.0114)	(0.0689)	(0.00270)
	Obs	51,272	51,272	24,125	54,460	54,460	29,855
EAC	$\widehat{\boldsymbol{\beta}}$	0.175***	1.351***	0.000833	-0.0755***	-0.515***	-0.00976***
	SE	(0.00912)	(0.0876)	(0.00204)	(0.00954)	(0.0687)	(0.00217)
	Obs	39,283	39,283	18,876	45,935	45,935	25,845
SRAC	$\widehat{\boldsymbol{\beta}}$	-0.374***	-3.339***	-0.00676***	-0.0446***	-1.470***	0.0104**
	SE	(0.00942)	(0.0812)	(0.00231)	(0.0132)	(0.0728)	(0.00471)
	Obs	44,603	44,603	20,431	47,696	47,696	26,081

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*