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Bunching Below Thresholds to Manipulate Public Procurement

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Global Governance Programme

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Abstract

I examine a manipulation scheme that public authorities can use to exercise more discretion in public procurement. I propose that regression discontinuity manipulation tests can be implemented to identify manipulative authorities. I investigate the European Union public procurement data set. I find that 10-13% of examined authorities have high probabilities of bunching estimated costs just below thresholds. Manipulative authorities have significantly lower probabilities of employing competitive procurement procedure. The bunching manipulation scheme significantly diminishes cost-effectiveness of public procurement. On average, prices of below threshold contracts are 18-28% higher when the authority has an elevated probability of bunching.

1 Introduction

EU countries annually spend 14% of their GDPs on public procurement (PP). Over 250,000 European Union (EU) public authorities acquire services, works and supplies worth 1.9 trillion Euros using different procurement procedures. Estimated costs and thresholds play an integral role in EU PP. European Commission describes that:[1] "EU law sets minimum harmonised rules for tenders whose monetary value exceeds a certain amount and which are presumed to be of cross-border interest. The European rules ensure that the award of contracts of higher value for the provision of public goods and services must be fair, equitable, transparent and non-discriminatory. For tenders of lower value however, **national rules apply** ..." Accordingly, public officials can have significantly higher levels of discretion over procurement process and awarding of the contract when estimated costs are below EU thresholds. Public officials can decide to use non competitive procedures like, direct purchase or negotiation. These procedures have significantly lower transparency requirements and may enable authorities to select firms. Authorities might be tempted to artificially provide lower estimated costs below EU thresholds to be able to implement non-competitive procurement methods. This manipulative practice is called "bunching below thresholds".

As stated by Palguta and Pertold (2017), public officials have more opportunities to manipulate procurement outcomes for below-threshold tenders. Therefore, authorities might manipulate estimated costs to be below thresholds to exercise more discretion. EU PP law recognizes this potential distortion. Article 5-3 of the 2014/24/EU addresses "bunching" estimated costs below thresholds. It states that "... choice of the method used to calculate the estimated

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[1] Available at: https://ec.europa.eu/growth/single-market/public-procurement/rules-implementation_en

value of a procurement shall not be made with the intention of excluding it from the scope of this Directive. A procurement shall not be subdivided with the effect of preventing it from falling within the scope of this Directive, unless justified by objective reasons." In this paper, I employ a regression discontinuity approach to determine the likelihood of bunching in EU PP. Specifically, I use a regression discontinuity manipulation test to identify authorities that have higher probabilities of bunching estimated values below EU thresholds. Then, I examine the impact of this manipulative scheme on PP outcomes.

I find that 10-13% of the authorities have very high probabilities of manipulating estimated costs. The empirical analysis finds that authorities that employ the bunching scheme are less likely to employ competitive procurement procedures like open procedure (first price auctions). Procurement prices are significantly higher in tenders conducted by bunching authorities. The bunching scheme significantly diminishes cost-effectiveness of public procurement. On average, prices of below threshold contracts are 18-28% higher when the authority has an elevated probability of bunching. Procurement prices of 844 construction contracts that are conducted by authorities with high bunching probabilities are 342,308 Euros higher compared to construction contracts below the threshold by other authorities. Similarly, average prices of 11,049 tenders by bunching authorities in other sectors is 11,174 Euros higher than contracts by non-bunching authorities. Directive 2014/24/EU states that the thresholds are 5,548,000 Euros for construction and 144,000 Euros for other contracts.[2]

Palguta and Pertold (2017) study manipulation of procurement values in the Czech Republic. A change in the Czech procurement law in 2006 allowed officials to determine procedures below a certain threshold. They find that ex-

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[2]In addition, thresholds for all services concerning social and other specific services listed in Annex XIV and all subsidized services are 750,000 and 221,000 Euros. Available at https://ec.europa.eu/growth/single-market/public-procurement/rules-implementation/thresholds_en.

cess number of contracts below the threshold increased dramatically after 2006. Coviello, et al. (2018) find that increased PP discretion in Italian municipalities is associated with larger chances of repeated wins by the same firm. They argue that discretion may improve PP outcomes. In contrast, Baltrunaite et al. (2018) find that discretion leads to an advantage of politically connected and less efficient firms. I contribute to the literature by quantifying the expected costs of the bunching manipulation scheme on PP outcomes. I show that regression discontinuity manipulation tests can be implemented effectively to identify potential manipulative authorities.

The remainder of this paper is organized as follows. Section 2 summarizes the EU PP data. Section 3 describes the empirical strategy to detect bunching manipulative behavior. Section 4 presents the extent of manipulation in the EU PP. Section 5 displays the empirical analysis of the impact of manipulation on EU PP and section 6 concludes.

2   Data

Data about EU PP data set is available as part of Tenders Electronic Daily (TED) data set. The TED data is available online in CSV format for years 2006-2017.[3] The EU extracts the data from the contract notice and contract award notice standard forms filled in by the authorities.[4] The original data set contains information on 5,303,219 PP contracts for the European Economic Area, Switzerland, and the former Yugoslav Republic of Macedonia. For each contract, the TED data includes variables about estimated cost, contract price, detailed CPV code of the subject of procurement, procurement method, types of

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[3]I use the contact award notices csv files. The files are available at https://data.europa.eu/euodp/data/dataset/ted-csv.

[4]The standard forms of the EU are available at "http://simap.ted.europa.eu/web/simap/standard-forms-for-public-procurement.

contracting authorities and detailed names and locations of procuring agencies and winning firms. The manipulation test employs the estimated cost variable. I examine the distribution of the official estimated cost for each contract to calculate the probability that an authority is manipulating estimated costs to be below the EU threshold values. Article 5-1 of the 2014/24/EU describes estimated cost as: "The calculation of the estimated value of a procurement shall be based on the total amount payable, net of VAT, as estimated by the contracting authority, including any form of option and any renewals of the contracts as explicitly set out in the procurement documents."

The estimated cost is available for 2,056,104 contracts. I employ the name and city of each authority to identify individual contracting entities. I identify 92,297 authorities from 31 countries. Figure 1 below displays the distribution of total number of contracts by each authority. 91% of the authorities conduct fewer than 30 tenders.
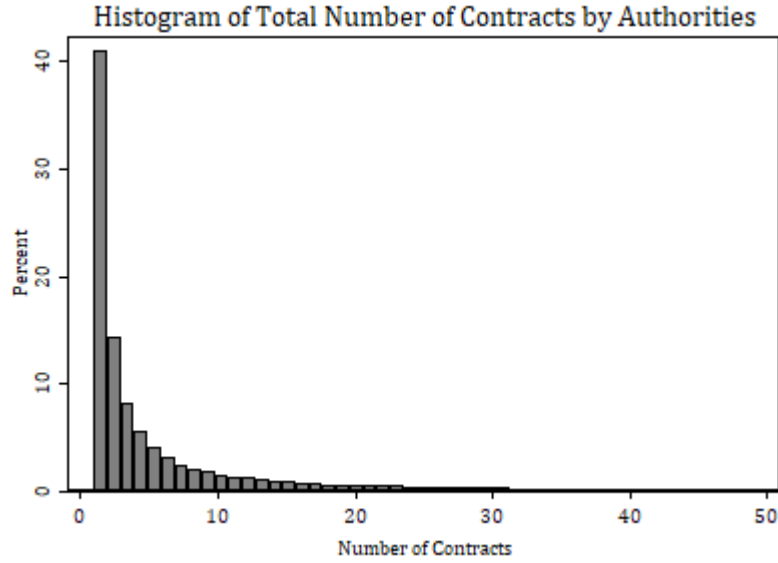
Figure 1: Histogram of Total Number of Contracts by Each Authority
Contracts larger than 50 are not displayed.

As stated by, Catteo, Jansson and Ma (2018) (CJM), a vital component
of manipulation testing is the bandwidth around the threshold. The choice of
bandwidth determines which observations near the cutoff are employed for cal-
culation of the test statistic. I implement the CJM methodology and determine
optimal bandwidths for each authority using the mean squared error (MSE) cri-
terion function. Catteo, Idrobo and Titiunik (2018b) state that "... bandwidths
much larger than the MSE-optimal bandwidth will lead to estimated RD effects
that have too much bias, and bandwidths much smaller than the MSE-optimal
choice will lead to RD effects with too much variance." (page 106) The ma-
nipulation test requires appropriate number of observations in the bandwidths.
Accordingly, I employ two alternative criteria to select the authorities for ma-
nipulation analysis. I analyze authorities with more than 20 observations or
30 observations in the bandwidth.[5] There are 2,044 and 1,416 authorities with

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[5] 10 (15) contracts below and above the threshold.

more than 20 and 30 observations in the bandwidth respectively. After elimination of authorities with insufficient number of contracts , I examine 260,167 and 219,391 contracts conducted by 2,044 and 1,416 authorities.

Authorities implement the competitive "OPEN" procedure for 86% of contracts. Remaining contracts are awarded using "award without prior publication of a contract notice" and negotiation procedures. Additionally, TED data set provides information about type of contracting authority like ministry or federal authority and regional or local authority. I employ 10 authority type dummy variables to control for authority specific characteristics as Kutlina-Dimitrova and Lakatos (2016).

3   Empirical Strategy

I employ the manipulation test based on density discontinuity of CJM. CJM describes the test as " ... test for a discontinuity in the density of a random sample of units that has been divided in two disjoint groups, according to a hard-thresholding rule based on an observed random variable ... and a known cutoff point." (page 3) I employ the thresholds stated at the 2014/24/EU directive on public procurement as cutoff points. I implement the CJM test separately to each public authority. The test determines whether authorities are systematically bunching estimated costs below EU thresholds (sorting around the cutoff points). In the absence of bunching, the density of observations (estimated costs) should be continuous. CJM proposes a local-polynomial density estimator to estimate the probability density function of estimated cost (c), $f(c)$. The manipulation test is a hypothesis test on the continuity of the density $f(c)$ at the EU threshold, T. The test can be formulated as following:

$$H_o : \lim_{c \uparrow T} f(c) = \lim_{c \downarrow T} f(c) \tag{1}$$

CJM provide an excellent description of the test in pages 5-13. I refrain from repetition and refer to CJM for details of the test.

I normalize the estimated costs with respect to the threshold.

$$NES_p = \frac{estimatedcost_p - threshold_p}{threshold_p}$$

The normalized estimated cost of procurement p, NES_p, is zero at the threshold. Figure 2 below displays the histograms of normalized estimated costs for non-bunching and bunching authorities identified by the CJM manipulation test. Part 2 of figure 2 shows that there is a spike just below the threshold for normalized estimated costs of bunching authorities. In comparison, the normalized estimated costs of non-bunching authorities are declining similar to the distribution of estimated costs in Czech Republic presented in Palguta and Pertold (2017).
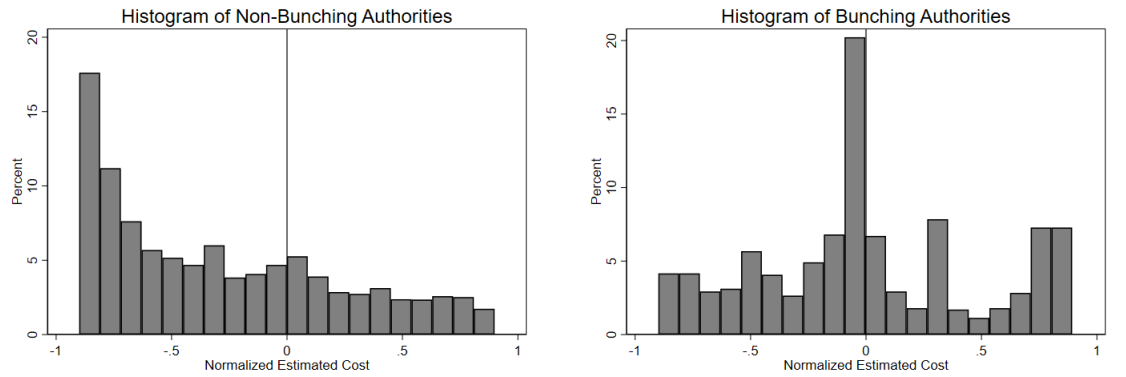
Figure 2: Normalized Estimated costs of Non-Bunching and Bunching Authorities

We calculate the manipulation test statistic with respect to normalized threshold value of zero. Figure 3 below displays the distribution of NES_p with respect to the thresholds for two sample authorities: non-bunching and bunching.

Sample Non-Bunching Authority   Sample Bunching Authority
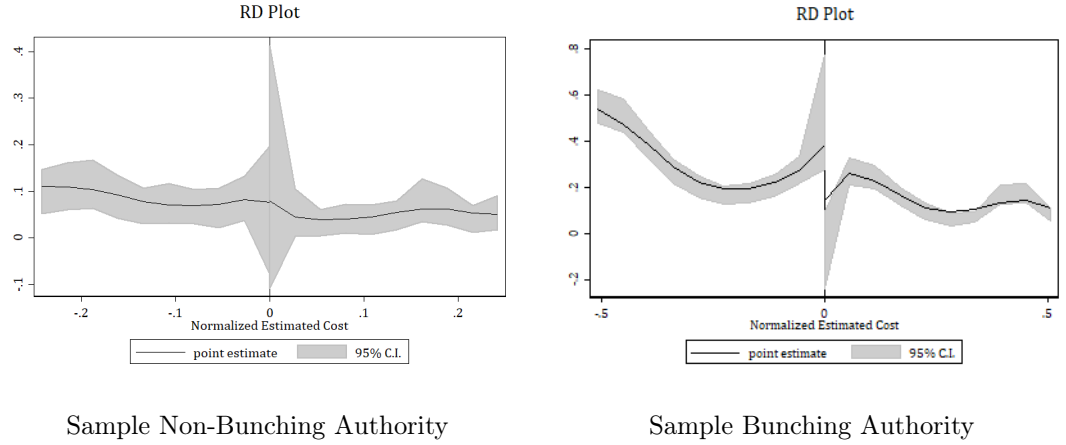
Figure 3: Regression Discontinuity Plots of sample Non-Bunching and Bunching Authorities

Figure 3 shows the intuition of the CJM manipulation test. The estimated cost is continuous in the first part of the graph for a non-bunching authority without a kink. In comparison, there is a major kink at the normalized threshold of zero for the bunching authority. There are significantly more contracts just below the threshold. Therefore, the test for the continuity of estimated costs conclude that probability of manipulation is significantly high for the authority in the second part of figure 3.

4   European Union Authorities and Bunching

After determining the suitable bandwidths, I calculate the discontinuity test

statistics for authorities with more than 20 and more than 30 observations in the bandwidth. 2,044 authorities have more than 20 and 1,416 have more than 30 observations in the bandwidth. Accordingly, I can safely calculate manipulation test statistics for these authorities. Figure 4 displays manipulation test p-values for these authorities.

2,044 authorities with more than 20 observations.

1,416 authorities with more than 30 observations.
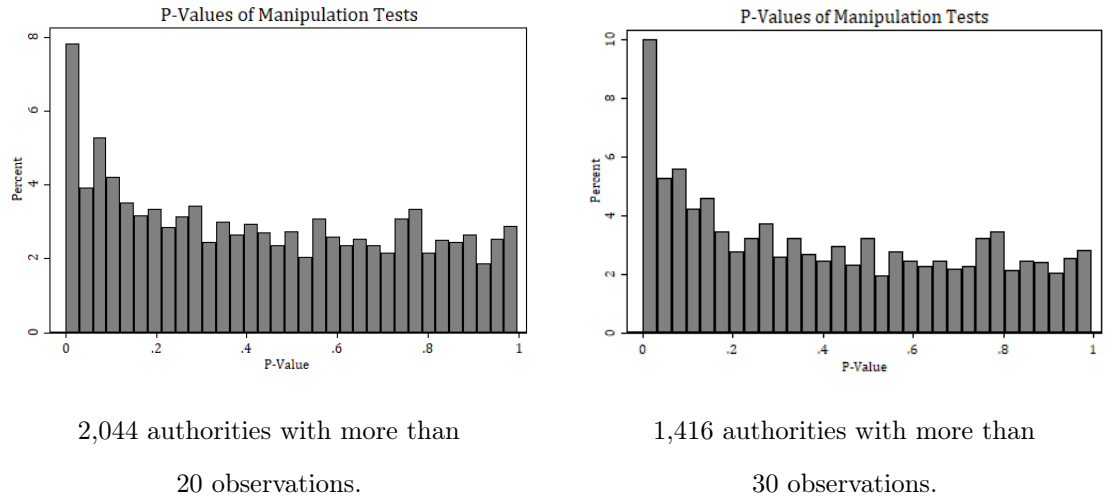
Figure 4: Histograms of Manipulation Test P-Values

Figure 4 displays that a number of authorities have p-values between 0 and 0.05. The null hypothesis of the test is that the values are continuous around the threshold. In other words, the values are not manipulated to be artificially below the threshold. For authorities with more than 20 observations, p-values are below 0.05 for 210 (10%) authorities and below 0.01 for 89 authorities. The test concludes that 210 authorities manipulate estimated costs to be below the threshold values. For authorities with more than 30 observations, p-values are below 0.05 for 178 (13%) authorities and below 0.01 for 79 authorities. Accordingly, manipulation tests suggest that 10-13% of the examined authori-

ties[6] potentially manipulate estimated costs to implement the "bunching below thresholds" scheme.

5 Impact of Bunching on Public Procurement

In this section, I examine the impact of the bunching manipulation scheme on PP. I study whether bunching authorities are more likely to implement non-competitive procurement procedures. Furthermore, I investigate the impact of bunching on PP cost-effectiveness.

5.1 Bunching and Choice of Competitive Procurement Procedure

Article 18-1 of the 2014/24/EU directive expresses the importance of competition as: "Contracting authorities shall treat economic operators equally and without discrimination and shall act in a transparent and proportionate manner. The design of the procurement shall not be made with the intention of excluding it from the scope of this Directive or of artificially narrowing competition. Competition shall be considered to be artificially narrowed where the design of the procurement is made with the intention of unduly favouring or disadvantaging certain economic operators." Bunching authorities may refrain from competitive procedures to be able to manipulate the PP process. To test this hypothesis, I estimate the logistic regression equation presented below to assess the effect of bunching on the probability of employing the competitive "OPEN" procedure which is a first price auction mechanism.

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[6] 2,044 authorities with more than 20 observations and 1,416 authorities with more than 30 observations in optimal bandwidths.

$$Pr(open_p = 1) = \beta_0 + M_p^{n,\alpha}\beta_1 + Control\theta + \varepsilon_p \qquad (2)$$

$Pr(open_p = 1)$ is the probability that the binary variable of open procedure is equal to 1 indicating that open procedure is implemented in procurement p. $M_p^{n,\alpha}$ is one if the manipulation test concludes that the official in procurement p is implementing the bunching manipulation scheme. n denotes whether the official has more than 20 or more than 30 observations. α is p-value of the manipulation test, 0.05 or 0.01. For example, $M_p^{20,0.05}$ is one when the entity has more than 20 observations in the bandwidth around the threshold and the p-value of the manipulation test is smaller than 0.05. I employ four alternative variables for manipulation to obtain robust results: $M_p^{20,0.05}$, $M_p^{20,0.01}$, $M_p^{30,0.05}$ and $M_p^{30,0.01}$. Finally, *Control* vector contains dummy variables for 9 authority types, 71 different sectors, 30 countries and 11 years. The coefficient of interest, β_1, gauges whether bunching authorities are less like to implement the competitive open procedure.

Similar to the existing studies like Palguta and Pertold (2017), equation 2 ignores the possibility that the manipulated variable, $M_p^{n,\alpha}$, might be endogenous. There might be unobserved characteristics that determine which officials will implement the bunching manipulation scheme. $M_p^{n,\alpha}$ might be endogenous because error term represents these unobserved characteristics. To take into account potential endogeneity of $M_p^{n,\alpha}$, I implement an instrumental variable (IV) GMM estimation of a linear probability model with robust standard errors. The TED data set contains a variable which denotes whether a contract is covered by the World Trade Organization (WTO) Government Procurement Agreement (GPA). The EU 'SIMAP' form for public procurement contains question IV.1.8 that asks whether the procurement is covered by the WTO GPA.[7]

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[7]Acronym for information system for public procurement (fr. systeme d'information pour les marches publics).

62,389 (42.5%) tenders of 146,704 contracts below threshold are covered by the WTO GPA.

The WTO GPA provides the Signatory Parties with a framework for ensuring that tenders covered by it are conducted in a competitive, non-discriminatory, and transparent manner, satisfying the conditions with regard to integrity. Article II of WTO GPA describes the scope and coverage of the agreement in detail.[8] Contracts covered by the WTO GPA are subject to additional scrutiny by international organizations and authorities. Accordingly, contracts covered by the WTO GPA are less likely to be manipulated by EU authorities. Table OA.1 in the Online Appendix confirms this argument. The first-stage regressions show that GPA Covered has a significant negative coefficient for all manipulation variables. WTO GPA covered contracts have significantly lower manipulation scores. The significant relationship between the endogenous variable, $M_p^{n,\alpha}$, and exogenous structure of GPA covered variable makes it an ideal candidate for a valid IV. Accordingly, I construct a variable that is 1 when when a contract is covered by the WTO GPA and 0 otherwise, GPA covered. I employ the GPA covered variable as the IV and estimate the linear probability model below.

$$open_p = \beta_0 + M_p^{n,\alpha}\gamma_1 + Control\theta + \varepsilon_p \qquad (3)$$

$open_p$ is the dummy variable that is one when an authority implements the open procedure. I estimate coefficients of equations 2 and 3 for below threshold contracts using Logit and IV GMM. Table 1 displays the estimation results. The coefficients of four alternative manipulated variables, $M_p^{n,\alpha}$, are significant with negative coefficients. Accordingly, table 1 concludes that bunching authorities have significantly lower probabilities of implementing the competitive open procedure.

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[8]The coverage schedules are available online at https://www.wto.org/english/tratop_e/gproc_e/gp_app_agree_e.htm.

(TABLE 1 ABOUT HERE.)

I implement the methodology of Conley et al. (2012) to assess the robustness of the IV GMM results. Conley et al. (2012) develop methods to obtain inferences when IVs are "plausibly exogenous." They define *plausible exogeneity* as the correlation between the IVs and endogenous variables being close to 0 but not exactly 0. This methodology can employ "instruments that are strong but may violate the exclusion restriction" (Conley et al. 2012, 261). Therefore, I conduct an additional robustness analysis by calculating confidence intervals of coefficients under the assumption that the IV, GPA Covered, is "plausibly exogenous." Table 2 shows the 95% lower and upper bounds of the coefficients, γ_1, of equation 3. Table 2 presents that coefficients of all manipulated variables are statistically significant and negative. Accordingly, the methodology of Conley et al. (2012) confirms the robustness and validity of IV GMM results of Table 1.

(TABLE 2 ABOUT HERE.)

The final robustness analysis implements the regression specification of Palguta and Pertold (2017) for the complete data set, 258,943 contracts including tenders with estimated costs above the thresholds. Palguta and Pertold (2017) employ the interaction variable of manipulation and estimated cost being below the threshold to assess the effect of manipulation on PP. Accordingly, I conduct further robustness analysis by estimating the coefficients of the following alternative regression specifications using logistic regression estimation and IV GMM with robust standard errors.

$$Pr(open_p = 1) = \gamma_0 + M_p^{n,\alpha} + BelowT_p\gamma_2 + Control\theta + \varepsilon_p \qquad (4)$$

$$Pr(open_p = 1) = \gamma_0 + M_p^{n,\alpha} * BelowT_p\gamma_1 + BelowT_p\gamma_2 + Control\theta + \varepsilon_p \quad (5)$$

$$open_p = \gamma_0 + M_p^{n,\alpha} + BelowT_p\gamma_2 + Control\theta + \varepsilon_p \quad (6)$$

$$open_p = \gamma_0 + M_p^{n,\alpha} * BelowT_p\gamma_1 + BelowT_p\gamma_2 + Control\theta + \varepsilon_p \quad (7)$$

In equations 4-7, γ_1 measures the effect of bunching officials on probability of open procedure in contracts with estimated costs below EU thresholds. $BelowT_p$ is one if estimated cost of procurement p is below EU thresholds. Online Appendix table OA.2 presents Logit estimation of equations 4 and 5. Table OA.3 presents IV GMM linear probability model estimation of equation 6 and 7.[9] All alternative regression specifications confirm the negative effect of bunching manipulation scheme on the probability that an authority employs competitive open procedure.

5.2 Bunching and Cost-Effectiveness

This section investigates whether bunching below thresholds by authorities impact procurement prices and cost-effectiveness. I follow the regression specification of Bajari et al. (2014) and estimate the effect of manipulative behavior on the ratio of procurement price and estimated cost. Bajari et al. (2014) show that using the ratio as the dependent variable improves the efficiency of regression estimates by controlling for heteroskedasticity. Specifically, I estimate

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[9]Table OA.4 in the online appendix present the Conley et al. (2012) lower and upper bounds of plausibly exogenous IV for IV GMM estimation of equations 6 and 7. Table OA.7 displays the first-stage regression results of IV GMM estimation of equations 6 and 7.

the following regression equation for below threshold contracts using IV GMM described above.[10]

$$\frac{contractprice_p}{estimatedcost_p} = \beta_0 + M_p^{n,\alpha}\beta_1 + Open_p\beta_2 + Control\theta + \varepsilon_p \qquad (8)$$

An alternative estimation strategy employs the description of OECD (2012) to identify cost-ineffective contracts. OECD (2012) states that "value for money" can be assessed by comparing the procurement price and estimated costs. Specifically, procurement prices that are higher than estimated cost are cost-ineffective. OECD (2012) suggests that public authorities should investigate these tenders. I employ the $Cost-Ineffective_p$ dummy variable as the dependent variable. Specifically, $Cost-Ineffective_p$ variable is one when the contract price is higher than the estimated cost. Then, I estimate the following linear probability model for below threshold contracts using IV GMM.

$$Cost-Ineffective_p = \beta_0 + M_p^{n,\alpha}\gamma_1 + Open_p\gamma_2 + Control\theta + \varepsilon_p \qquad (9)$$

$Open_p$ is one when an official uses the open procedure. As in section 5.1, I employ the GPA Covered variable as IV. Table 3 displays the IV GMM estimation of equations 8 and 9. All manipulated variables in Table 3 have significant positive coefficients. Therefore, contract price compared to the estimated cost is significantly higher when a manipulative authority conducts the procurement. The likelihood that the contract is cost-ineffective increases significantly when the authority has a high probability of implementing the bunching manipulation

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[10]I implement Billor et al.'s (2000) BACON methodology (blocked adaptive computationally efficient outlier nominators) to identify the outliers. The BACON method identifies contracts with ratios lower than 0.25 and higher than 1.87 as outliers. I remove 6,933 contracts with unrealistic values.

scheme.

(TABLE 3 ABOUT HERE.)

I perform robustness analysis by calculating confidence intervals of coefficients under the assumption that the IV, GPA Covered, is plausibly exogenous. Table 4 presents the 95% lower and upper bounds of the coefficients β_1 and γ_1 of equations 8 and 9. Confidence intervals with plausibly exogenous IV confirms the robustness and validity of IV GMM results of Table 3.

(TABLE 4 ABOUT HERE.)

Finally, I employ the regression specification of Palguta and Pertold (2017) for the complete data set, 184,218 contracts including tenders with estimated costs above the thresholds.

$$\frac{contractprice_p}{estimatedcost_p} = \beta_0 + M_p^{n,\alpha}\beta_1 + Open_p\beta_2 + BelowT_p\beta_3 + Control\theta + \varepsilon_p \quad (10)$$

$$\frac{contractprice_p}{estimatedcost_p} = \gamma_0 + M_p^{n,\alpha}*BelowT_p\gamma_1 + Open_p\beta_2 + BelowT_p\beta_3 + Control\theta + \varepsilon_p \quad (11)$$

Table OA.5 in the Online Appendix show the IV GMM estimation of equations 10 and 11. Table OA.6 presents that lower and upper bounds for plausibly exogenous instruments. Alternative regression specification results of Tables OA.5 and OA.6 validate the findings of tables 3 and 4. Bunching below thresholds manipulation scheme substantially rises procurement costs and diminishes cost-effectiveness of PP contracts. Back of the envelope calculations show that prices of below threshold construction tenders conducted by bunching authorities are on average 342,308-602,791 Euros (for $M_p^{10,0.05}$ and $M_p^{15,0.01}$)

higher. Similarly, average costs of contracts in other sectors are on average 11,174-15,756 Euros (for $M_p^{10,0.05}$ and $M_p^{15,0.01}$) higher.

6   Conclusion

In this paper, I detect the manipulative scheme of bunching below thresholds in EU public procurement. I employ regression discontinuity manipulation tests to identify authorities that manipulate estimated costs of contracts to be just below EU thresholds. 10-13% of examined authorities have high probabilities of implementing the manipulative scheme. I find that manipulative officials are less likely to use the competitive open procurement procedure. I quantify the impact of manipulation on EU PP cost-effectiveness. Contract prices compared to estimated costs are significantly higher in tenders conducted by bunching authorities. The bunching scheme significantly diminishes cost-effectiveness of public procurement. Procurement prices of 844 construction contracts that are conducted by authorities with high bunching probabilities are 342,308 Euros higher compared to construction contracts below the threshold by other authorities. Similarly, average prices of 11,049 tenders by bunching authorities in other sectors is 11,174 Euros higher than contracts by non-bunching authorities. The findings of the paper suggest that public officials can implement regression discontinuity manipulation tests to detect manipulative authorities.

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Table 1

Effect of Manipulation on Probability of Competitive Procedure (Open)

	Logit				IV GMM Linear Probability			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manipulated (n=20, p=0.05)	-0.49 (16.37)**							
Manipulated (n=20, p=0.01)		-0.47 (11.99)**						
Manipulated (n=30, p=0.05)			-0.52 (16.53)**					
Manipulated (n=30, p=0.01)				-0.48 (12.08)**				
Manipulated Interaction (n=20, p=0.05)					-0.65 (11.17)**			
Manipulated Interaction (n=20, p=0.01)						-1.13 (10.28)**		
Manipulated Interaction (n=30, p=0.05)							-1.09 (15.76)**	
Manipulated Interaction (n=30, p=0.01)								-1.46 (14.46)**
Constant	16.45 (0.03)	15.97 (0.04)	16.18 (0.03)	17.33 (0.02)	0.97 (20.82)**	0.99 (22.53)**	0.35 (4.05)	-2.30 (19.14)**
Observations	165,359	165,359	137,946	137,946	146,704	146,704	123,695	218,334
Authority Type Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$. Robust z statistics in parentheses.

Table 2

**Robustness Analysis of Instrumental Variables in IV GMM Linear Probability Model
Plausibly Exogenous Instrument**

Variable	95% Lower Bound	95% Upper Bound
Manipulated (n=20, p=0.05)	-1.33	-0.37
Manipulated (n=20, p=0.01)	-2.21	-0.59
Manipulated (n=30, p=0.05)	-1.31	-0.63
Manipulated (n=30, p=0.01)	-2.19	-1.02

Table 3

Effect of Manipulation on Procurement Cost-Effectiveness
IV GMM with GPA-Covered as Instrumental Variable

	Ratio				Cost-Ineffective			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manipulated	0.18				0.42			
(n=20, p=0.05)	(4.70)**				(6.97)**			
Manipulated		0.30				0.69		
(n=20, p=0.01)		(4.65)**				(6.84)**		
Manipulated			0.24				0.40	
(n=30, p=0.05)			(6.12)**				(6.10)**	
Manipulated				0.28				0.57
(n=30, p=0.01)				(5.09)**				(6.04)**
Open Procedure	-0.06	-0.06	-0.05	-0.05	-0.01	-0.00	-0.01	-0.01
	(24.07)**	(22.84)**	(15.81)**	(18.15)**	(1.67)	(0.97)	(2.62)**	(2.13)
Constant	0.91	0.91	-0.41	1.02	0.06	0.14	0.11	-0.02
	(30.06)**	(30.08)**	(7.35)**	(23.43)**	(12.63)**	(2.15)**	(46.31)**	(0.84)
Observations	125,517	125,517	108,053	108,053	125,517	125,517	108,053	108,053
Authority Type Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$. Dependent variable is the ratio of procurement price and estimated cost. IV GMM estimation with GPA Covered IV variable. Robust z statistics in parentheses.

Table 4

Robustness Analysis of Instrumental Variables in IV GMM
Plausibly Exogenous Instruments

Variable	95% Lower Bound	95% Upper Bound
Dependent Variable: Ratio		
Manipulated (n=20, p=0.05)	0.13	0.56
Manipulated (n=20, p=0.01)	0.22	0.47
Manipulated (n=30, p=0.05)	0.23	0.40
Manipulated (n=30, p=0.01)	0.28	0.56
Dependent Variable: Cost-Ineffective		
Manipulated (n=20, p=0.05)	0.33	0.85
Manipulated (n=20, p=0.01)	0.54	1.39
Manipulated (n=30, p=0.05)	0.30	0.83
Manipulated (n=30, p=0.01)	0.43	1.18

Online Appendix: (Not for Publication)

Table OA.1

First-Stage Regressions

	Dependent Variable			
	Manipulated (n=20, p=0.05)	Manipulated (n=20, p=0.01)	Manipulated (n=30, p=0.05)	Manipulated (n=30, p=0.01)
GPA Covered	-0.03	-0.02	-0.04	-0.03
	(20.01)**	(15.34)**	(20.32)**	(18.54)**
Authority Type Fixed Effects	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$.

Table OA.2
Effect of Manipulation on Probability of Competitive Procedure (Open)

	Logit				Logit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manipulated (n=20, p=0.05)	-0.49 (16.37)**							
Manipulated (n=20, p=0.01)		-0.41 (17.33)**						
Manipulated (n=30, p=0.05)			-0.29 (15.08)**					
Manipulated (n=30, p=0.01)				-0.42 (17.24)**				
Manipulated Interaction (n=20, p=0.05)					-0.44 (15.93)**			
Manipulated Interaction (n=20, p=0.01)						-0.41 (11.63)**		
Manipulated Interaction (n=30, p=0.05)							-0.47 (16.03)**	
Manipulated Interaction (n=30, p=0.01)								-0.44 (12.09)**
Constant	16.45 (0.03)	17.50 (0.02)	18.03 (0.01)	18.01 (0.01)	17.46 (0.02)	17.49 (0.02)	17.97 (0.01)	18.01 (0.01)
Observations	258,943	258,943	218,334	218,334	258,943	258,943	218,334	218,334
Authority Type Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$. Robust z statistics in parentheses.

Table OA.3
Effect of Manipulation on Probability of Competitive Procedure (Open)

	IV GMM Linear Probability				IV GMM Linear Probability			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manipulated	-0.07							
(n=20, p=0.05)	(2.55)*							
Manipulated		-0.10						
(n=20, p=0.01)		(2.50)*						
Manipulated			-0.16					
(n=30, p=0.05)			(7.02)**					
Manipulated				-0.22				
(n=30, p=0.01)				(5.95)**				
Manipulated Interaction					-0.07			
(n=20, p=0.05)					(2.51)*			
Manipulated Interaction						-0.11		
(n=20, p=0.01)						(2.49)*		
Manipulated Interaction							-0.18	
(n=30, p=0.05)							(6.02)**	
Manipulated Interaction								-0.23
(n=30, p=0.01)								(6.03)**
Below Threshold	-0.02	-0.01	-0.02	-0.02	-0.00	-0.00	0.01	0.01
	(7.60)**	(8.34)**	(11.52)**	(10.29)**	(0.63)	(1.56)	(3.16)**	(2.04)*
Constant	-0.06	-0.00	0.09	-0.04	-0.01	0.03	-0.05	-0.06
	(1.36)	(2.75)**	(3.56)**	(4.89)**	(1.74)	(0.80)	(1.61)	(4.66)**
Observations	200,672	200,672	173,307	173,307	200,672	200,672	173,307	173,307
Authority Type Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$. Robust z statistics in parentheses.

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Table OA.4
Robustness Analysis of Instrumental Variables in IV GMM Linear Probability Model
Plausibly Exogenous Instrument

Variable	95% Lower Bound	95% Upper Bound
Manipulated (n=20, p=0.05)	-0.12	-0.02
Manipulated (n=20, p=0.01)	-0.19	-0.02
Manipulated (n=30, p=0.05)	-0.19	-0.1
Manipulated (n=30, p=0.01)	-0.29	-0.15
Manipulated Interaction (n=20, p=0.05)	-0.13	-0.02
Manipulated Interaction (n=20, p=0.01)	-0.13	-0.02
Manipulated Interaction (n=30, p=0.05)	-0.23	-0.12
Manipulated Interaction (n=30, p=0.01)	-0.31	-0.16

Table OA.5
Effect of Manipulation on Procurement Cost-Effectiveness
IV GMM with GPA-Covered as Instrumental Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manipulated (n=20, p=0.05)	0.27 (4.98)**							
Manipulated (n=20, p=0.01)		0.69 (4.35)**						
Manipulated (n=30, p=0.05)			0.16 (4.02)**					
Manipulated (n=30, p=0.01)				0.37 (3.79)**				
Manipulated Interaction (n=20, p=0.05)					0.19 (4.91)**			
Manipulated Interaction (n=20, p=0.01)						0.28 (4.90)**		
Manipulated Interaction (n=30, p=0.05)							0.15 (4.31)**	
Manipulated Interaction (n=30, p=0.01)								0.17 (3.40)**
Open Procedure	-0.06 (32.38)**	-0.05 (15.03)**	-0.05 (28.48)**	-0.04 (17.60)**	-0.06 (34.75)**	-0.06 (34.12)**	-0.05 (29.29)**	-0.05 (28.62)**
Below Threshold	0.01 (4.98)**	0.01 (3.19)**	0.00 (1.86)	0.00 (0.44)	-0.02 (4.33)**	-0.01 (3.85)**	-0.02 (4.32)**	-0.01 (3.39)**
Constant	0.90 (28.96)**	0.91 (29.16)**	0.05 (30.85)**	-0.00 (0.07)	-0.18 (18.61)**	0.06 (60.66)**	0.97 (22.42)**	-2.24 (19.12)**
Observations	184,218	184,218	158,511	158,511	184,218	184,218	158,511	158,511
Authority Type Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$. Dependent variable is the ratio of procurement price and estimated cost. IV GMM estimation with GPA Covered IV variable. Robust z statistics in parentheses.

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Table OA.6
Robustness Analysis of Instrumental Variables in IV GMM
Plausibly Exogenous Instruments

Variable	95% Lower Bound	95% Upper Bound
Manipulated (n=20, p=0.05)	0.21	0.9
Manipulated (n=20, p=0.01)	0.38	1.01
Manipulated (n=30, p=0.05)	0.2	0.38
Manipulated (n=30, p=0.01)	0.47	1.05
Manipulated Interaction (n=20, p=0.05)	0.13	1
Manipulated Interaction (n=20, p=0.01)	0.19	0.41
Manipulated Interaction (n=30, p=0.05)	0.18	0.34
Manipulated Interaction (n=30, p=0.01)	0.25	0.46

Table OA.7

First-Stage Regressions

	Dependent Variable			
	Manipulated (n=20, p=0.05)	Manipulated (n=20, p=0.01)	Manipulated (n=30, p=0.05)	Manipulated (n=30, p=0.01)
GPA Covered	-0.013	-0.02	-0.04	-0.03
	(22.22)**	(19.63)**	(26.31)**	(21.46)**
Authority Type Fixed Effects	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$.

First-Stage Regressions

	Dependent Variable			
	Manipulated Interaction (n=20, p=0.05)	Manipulated Interaction (n=20, p=0.01)	Manipulated Interaction (n=30, p=0.05)	Manipulated Interaction (n=30, p=0.01)
GPA Covered	-0.03	-0.02	-0.03	-0.03
	(30.16)**	(28.17)**	(29.36)**	(29.30)**
Authority Type Fixed Effects	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: * $p<0.05$; ** $p<0.01$.

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