Detecting authorities that manipulate public procurement

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Detecting authorities that manipulate public procurement

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Abstract

Manipulative authorities can bunch tenders just below thresholds to implement noncompetitive procurement practices in public procurement. Here, I use regression discontinuity manipulation tests to identify this bunching manipulation scheme. I investigate the European Union public procurement data set that covers more than two million contracts. The results show that 10-13% of the examined authorities have high probabilities of bunching manipulation. I study the impact of manipulation by authorities on public procurement. I find that manipulative authorities are less likely to employ competitive procurement procedures. Local firms are more likely to win contracts from a manipulative authority. The bunching scheme increases the probability that the same firm wins contracts repeatedly. Empirical results suggest that policy makers can effectively employ regression discontinuity tests to determine manipulative authorities.

Introduction

International organizations and public administrators promote open auctions in public procurement (PP)[1]. However, open auctions might also increase transaction and time costs and reduce procurement quality[2-4]. Accordingly, many countries, including the US and the European Union (EU), allow public officials to exercise their own discretion. Authorities can implement noncompetitive procedures (e.g., a direct purchase) if the estimated cost is below a certain threshold. These procedures have significantly lower transparency requirements and enable authorities to select firms. Here, authorities may provide artificially low estimated costs that fall just below thresholds to implement noncompetitive procurement methods. This manipulative practice is called *bunching below thresholds*[5].

The EU PP law specifically addresses the bunching below thresholds manipulation scheme. Article 5-3 of 2014/24/EU directive expresses "... choice of the method used to calculate the estimated value of a procurement shall not be made with the intention of excluding it from the scope of this Directive." Government agencies require statistical tools to identify manipulative authorities that artificially bunch estimated costs below thresholds to manipulate public procurement. The European Court of Auditors emphasizes this need by stating "... the (EU) Commission lacks comprehensive information on the scale, nature and causes of fraud"[6]. This paper makes three contributions to this discussion. First, I propose using regression discontinuity manipulation tests to identify authorities that have high probabilities of bunching manipulation. Second, I investigate an extensive data set to determine the scope of bunching manipulation in the EU PP. I identify the EU authorities that are likely to implement the bunching manipulation scheme. Finally, I examine the impact of this manipulative scheme on EU PP outcomes.

European countries spend 14% of their GDP on PP. Annually, over 250,000 European public authorities acquire services, works, and supplies worth EUR 1.9 trillion using various procurement procedures. The

Tenders Electronic Daily (TED) data set contains extensive information about EU PP for 2006-2017. I find that 10-13% of the examined authorities exhibit a very high probability of manipulating estimated costs. Authorities that employ the bunching scheme are considerably less likely to use the competitive open procurement procedure, first-price auction. In such cases, local firms are significantly more likely to win contracts, and there is a greater probability of the same firm winning repeatedly.

Results

I employ the manipulation test based on density discontinuity to identify manipulative authorities[7]. I use the thresholds stated in the 2014/24/EU directive on PP as cutoff points. I implement the test separately for each public authority with sufficient number of observations. The test determines whether an authority is 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. First, I normalize the estimated costs with respect to the threshold. The normalized estimated cost of procurement is zero at the threshold. Figure 1 displays histograms of the normalized estimated costs for nonbunching and manipulative (bunching) authorities, as identified by the manipulation test.

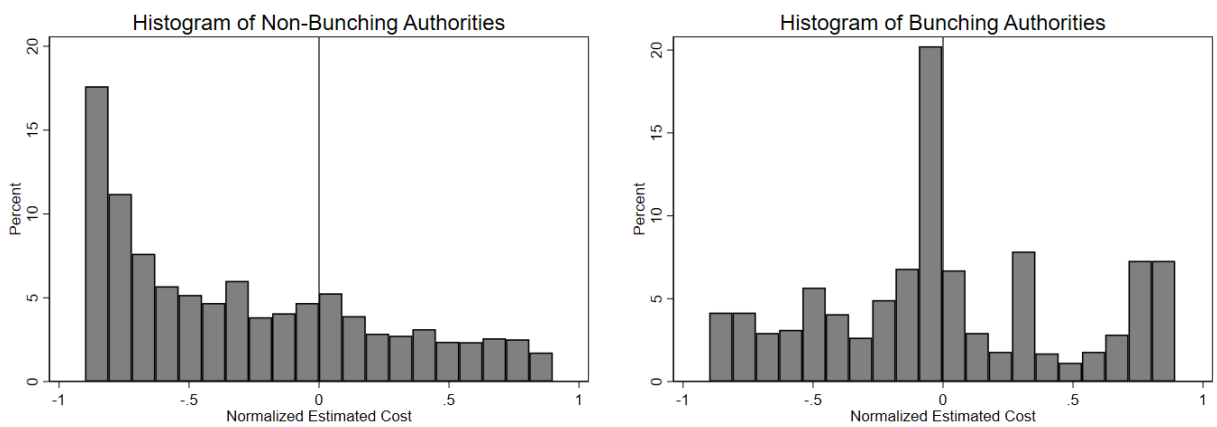


Figure 1: Normalized Estimated Costs of Nonbunching and Bunching Authorities

Part 2 of Figure 1 shows a spike just below the threshold for the normalized estimated costs of bunching authorities. In contrast, those of nonbunching authorities are declining. The spike in Figure 1 implies that manipulative authorities artificially bunch estimated costs just below the relevant thresholds.

European Public Procurement and Bunching

I start the analysis by examining bunching for all contracts. I employ the regression-based methodology to calculate the counterfactual density by estimating a regression of the following form[8].

$$C_j = \sum_{i=0}^{q} \beta_i . (Z_j)^i + \varepsilon_j$$

where C_j is the number of individuals in the bracket j, Z_j is a normalized cost interval $Z_j = \{-20, -19, \ldots, 19, 20\}$, and q is the order of the polynomial. The counterfactual distribution is based on the predicted values from this regression, omitting the dummy at the threshold. I first group individuals into 0.05 bins with respect to the normalized estimated costs. For example, bracket [-0.05, 0] corresponds to contracts just below the thresholds with estimated values [198550, 209000] for goods and services and [4963750, 5225000] for construction. Figure 2 plots the empirical distribution of the normalized estimated costs of all contracts.

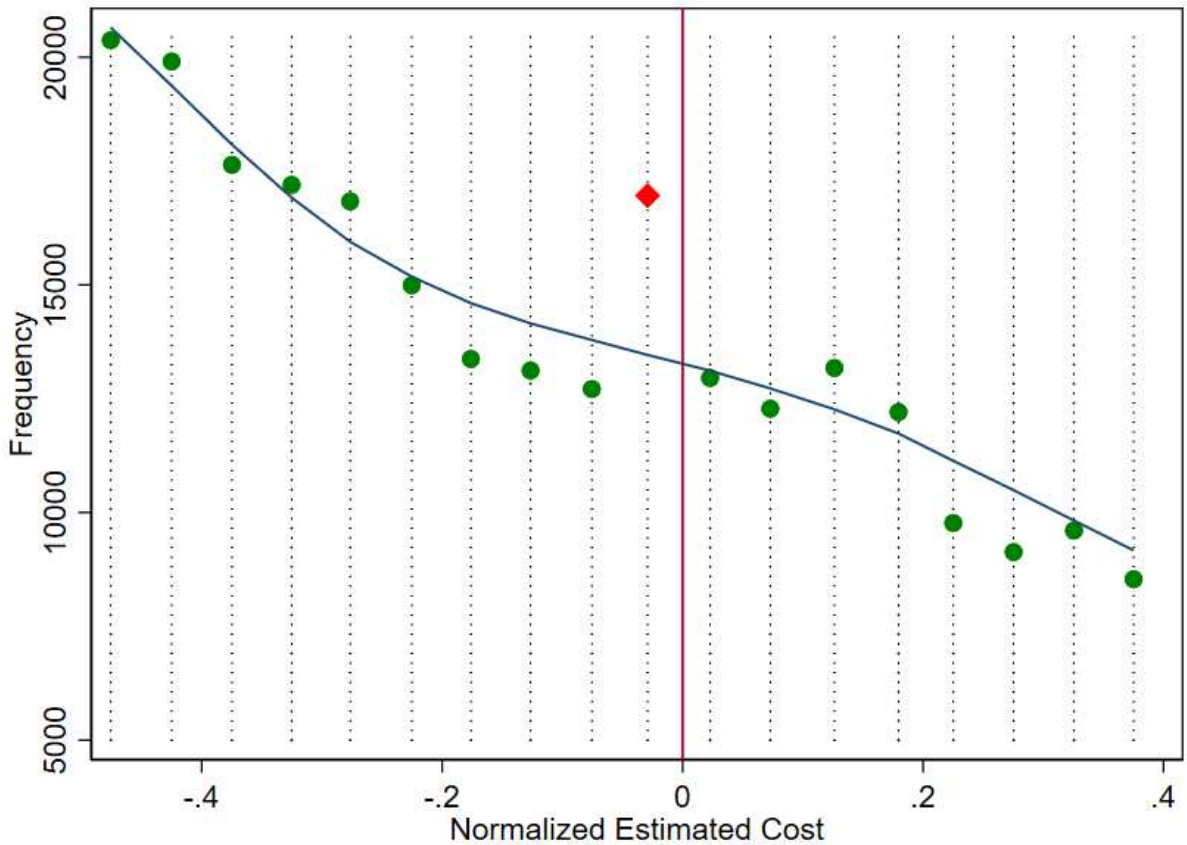


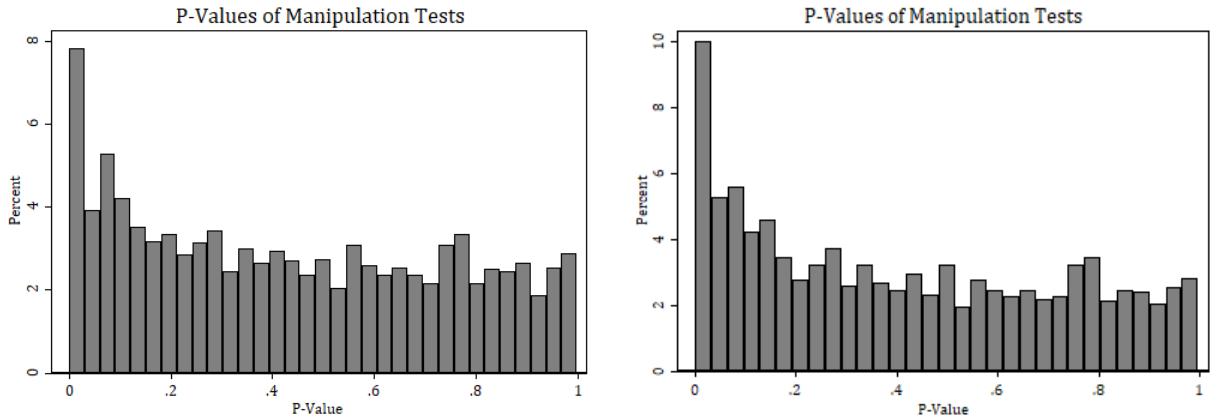
Figure 2: Distribution of Total Number of Contracts with Respect to Normalized Estimated Cost. The figure displays 20 brackets around the threshold. The red diamond presents the bracket just below the threshold, [-0.05, 0].

Figure 2 shows a dramatic spike at the bracket just below the threshold (presented by the red diamond) in the otherwise monotonically declining normalized estimated cost distribution. The counterfactual density analysis of the figure provides preliminary evidence of bunching behavior in European PP. The analysis does not differentiate between authorities because it examines all contracts.

The main aim of this study is to identify individual authorities that have high bunching manipulation probabilities. Regression discontinuity manipulation tests allow us to assess the manipulation probabilities of individual authorities. Analyzing discontinuity in European PP is nontrivial because contracts and authorities differ substantially. The EU PP data set covers contracts for different sectors, countries, authority types, and estimated costs, among many other distinctive properties. Therefore, I employ a test that does not require prebinning of the data. Alternative tests require that several tuning parameters be set before

conducting the test[9,10]. Determining suitable parameters for each authority is challenging and prone to bias because each authority and contract has many distinctive properties.

I employ the flexible data-driven procedures to calculate the optimal bandwidths for each authority. The methodology determines the optimal bandwidth that minimizes the asymptotic mean squared error. I allow for different bandwidths on either side of the cutoff. After determining the optimal bandwidths for each authority, I calculate the discontinuity test statistics for those authorities with more than 20 and more than 30 observations in the band. Figure 3 presents the manipulation test p-values for these authorities.



2,044 authorities with more than 20 observations. 1,416 authorities with more than 30 observations.

Figure 3: Histograms of Manipulation Test P-Values

Figure 3 shows that many authorities have p-values between 0 and 0.05. The null hypothesis of the test is that the estimated cost is continuous around the threshold. In other words, the authority does not manipulate its estimated costs to be artificially below the threshold. For authorities with more than 20 observations, the p-values are below 0.05 for 210 (10%) authorities, and below 0.01 for 89 authorities. This result shows that 210 authorities manipulate their estimated costs to be below the threshold values. For authorities with more than 30 observations, the p-values are below 0.05 for 178 (13%) authorities, and below 0.01 for 79 authorities. These findings suggest that 10-13% of the examined authorities potentially manipulate their estimated costs to implement the "bunching below thresholds" scheme.

Impact of Bunching on Public Procurement Procedures

The analysis above presents the extent of the bunching below threshold manipulative behavior in European PP. In this section, I examine the impact of such schemes on PP outcomes. As such, I investigate whether bunching authorities are more likely to implement noncompetitive procurement procedures. Furthermore, I investigate the likelihood that bunching authorities select local and incumbent firms. I examine 413,121 contracts that are below the EU threshold. These results display how manipulative authorities use their discretion that they obtain when they artificially lower their estimated costs below the EU threshold.

Manipulative authorities may refrain from competitive procedures. To test this hypothesis, I estimate the following logistic regression equation to assess the effect of bunching on the probability of employing the competitive "open" procedure, which is a first-price auction mechanism:

$$Pr(open_p = 1) = \beta_0 + M_p^{n,\alpha}\beta_1 + Control_p + \varepsilon_p$$

$\Pr(\mathrm{open_p} = 1)$ is the probability that the binary variable of the open procedure is equal to 1, indicating that the open procedure is implemented in procurement p; $\mathrm{M_p^{n,\alpha}}$ is 1 if the manipulation test concludes that the official in procurement p is implementing a bunching manipulation scheme. n denotes whether the official has more than 20 or more than 30 observations; α is the p-value of the manipulation test, 0.05 or 0.01. For example, $\mathrm{M_p^{20,0.05}}$ is 1 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: $\mathrm{M_p^{20,0.05}}$, $\mathrm{M_p^{20,0.01}}$, $\mathrm{M_p^{30,0.05}}$ and $\mathrm{M_p^{30,0.01}}$. Finally, $Control_p$ vector contains dummy variables for 9 authority types, 45 sectors, 30 countries and 11 years. The coefficient of interest, β_1, gauges whether bunching authorities are less likely to implement the competitive open procedure.

Table 1 displays the estimation results. The coefficients of the four alternative manipulated variables, $\mathrm{M_p^{n,\alpha}}$, are significant and have negative coefficients. Table 1 shows that bunching authorities have significantly lower probabilities of implementing the competitive open procedure. Authorities that are likely to use the bunching manipulation scheme employ more discretionary procedures. Compared with the open procedure, these discretionary procedures might allow authorities to limit competition and select suppliers.

Table 1
Effect of Manipulation on Procurement Method

	Uncompetitive Procurement Method			
	(1)	(2)	(3)	(4)
Manipulated (n=30, p=0.01)	0.13 (3.97)**			
Manipulated (n=30, p=0.05)		0.14 (5.47)**		
Manipulated (n=20, p=0.01)			0.13 (4.43)**	
Manipulated (n=20, p=0.05)				0.21 (8.96)**
Constant	-2.56 (20.98)**	-2.56 (20.99)**	-2.45 (24.66)**	-2.46 (24.71)**
Observations	328,936	328,936	412,976	412,976
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. Heteroskedasticity-consistent test statistics are presented in parentheses.

Bunching Manipulation and Winner Firm Characteristics

This section investigates whether firms that are awarded contracts by authorities with a high manipulation probability have distinctive characteristics. Specifically, I examine whether bunching manipulation increases the probability that the same firm wins repeatedly and the probability that local firms win contracts.

The TED data set contains detailed information on winning bidders. I use this information to construct measures for the characteristics of winner firms. I set the *Local Winner* variable to 1 if the winning firm is in the same city as that of the procuring authority[11]. For each contract, I define that winner firm as an *Incumbent Winner* if it has won at least one contract from the same authority within a year of the current procurement. I estimate the following logistic regression equation to assess the effect of bunching manipulation:

$$Pr(char_w = 1) = \beta_0 + M_p^{n,\alpha}\beta_1 + Control_p + \varepsilon_p$$

$\Pr(char_w = 1)$ is the probability that the binary variables for the winner firm characteristics, *Local Winner* or *Incumbent Winner*, equal to 1, for winner firm w. $\mathrm{M}_\mathrm{p}^{\mathrm{n},\alpha}$ and $Control_p$ are described above.

Table 2 displays the estimation results for *Local Winner* and *Incumbent Winner*. The coefficients of the four alternative manipulated variables, $\mathrm{M}_\mathrm{p}^{\mathrm{n},\alpha}$, are significant and have positive coefficients for both *Local Winner* and *Incumbent Winner*. Table 2 shows that firms located in the same city as the authority have a significantly higher probability of winning a contract if the authority has a high likelihood of implementing a bunching manipulation scheme. Similarly, bunching manipulation increases the probability of the same firm winning repeatedly. Incumbent winners are more likely to be awarded contracts by manipulative authorities.

Table 2
Bunching Manipulation and Winner Firm Characteristics

	Local Winner				**Incumbent Winner**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manipulated	0.20				0.26			
(n=30, p=0.01)	(11.83)**				(16.67)**			
Manipulated		0.08				0.14		
(n=30, p=0.05)		(5.67)**				(12.51)**		
Manipulated			0.10				0.31	
(n=20, p=0.01)			(6.40)**				(21.75)**	
Manipulated				0.05				0.18
(n=20, p=0.05)				(4.29)**				(16,65)**
Constant	-0.82	-0.13	-0.71	-0.09	0.83	0.84	0.79	0.80
	(10.10)**	(3.91)**	(10.17)**	(3.29)**	(14.04)**	(14.20)**	(15.32)**	(15.43)**
Observations	313,634	313,634	394,327	394,327	329,064	329,064	413,121	413,121
Authority	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * p<0.05; ** p<0.01. Local Winner is a dummy variable equal to one if the winning firm is in the same city of the public buyer. Incumbent Winner is a dummy variable equal to one for a winner that has won at least one other contract held by the same buyer within a year from the current auction. Heteroskedasticity-consistent test statistics in parentheses.

Discussion

This paper shows that regression discontinuity manipulation tests can be effectively used to identify authorities that manipulate estimated costs of contracts to be just below thresholds. I analyze the manipulative scheme of "bunching below thresholds" in the context of EU PP. The findings of this study suggest that public officials can implement regression discontinuity manipulation tests to detect potentially manipulative authorities. A significant advantage of the manipulation test is that it does not require detailed data and complicated theoretical analysis. Officials can implement the methodology using the existing data about public procurement outcomes.

This study contributes to the literature in several ways. First, I show that regression discontinuity manipulation tests can be used effectively to identify manipulative authorities. Second, I determine the prevalence of the bunching manipulation scheme in EU PP. Third, I examine the impact of manipulation using the variation in manipulation probabilities of individual authorities. Existing studies use law and policy changes to identify the impact of bunching on PP outcomes[12]. They compare bunching and the effect of discretion before and after a relevant reform. In contrast, I can identify manipulative authorities and investigate the economic impact of bunching using the manipulation probabilities of these authorities.

Methods and Data

Test of Bunching for All Contracts

Figure 2 calculates the counterfactual distribution of estimated costs[8]. The solid blue curve shows the counterfactual density predicted using a seventh-degree polynomial (q=7). I calculate the standard error for the estimated coefficients using a bootstrap procedure with 1000 replications. The bootstrap standard errors reflect the estimation error of the counterfactual distribution. Therefore, excess mass at the threshold can be tested. The test rejects the null hypothesis that there is no excess mass at the threshold, with a chi-squared test statistic of 215.1, implying p-value = 0.00.

Manipulation Tests

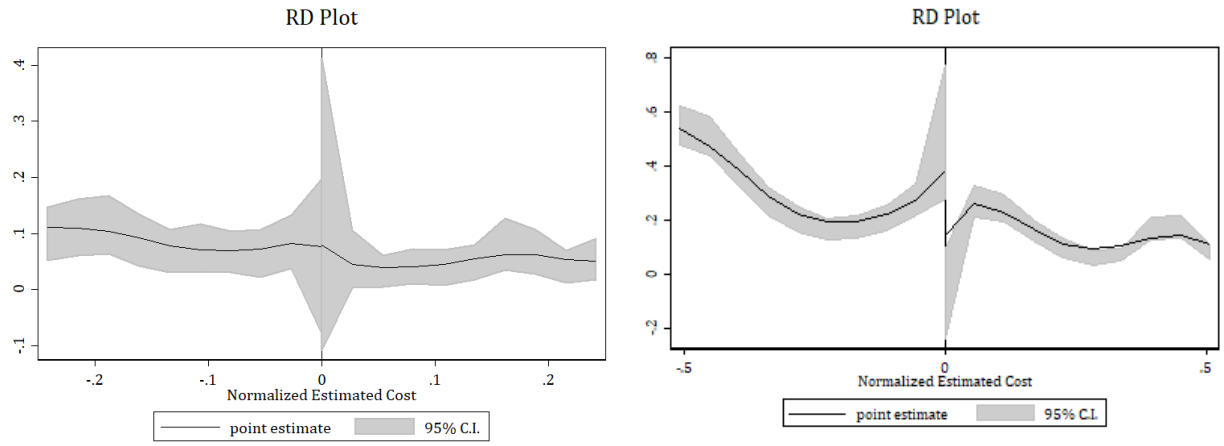
I employ the manipulation test based on density discontinuity to identify manipulative authorities. I use the thresholds stated in the 2014/24/EU directive on PP as cutoff points. I implement the test separately for each public authority with sufficient number of observations. The test determines whether an authority is 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. The local-polynomial density estimator to estimate the probability density function of the estimated cost (c), f(c)[7,9]. The manipulation test is a hypothesis test on the continuity of the density f(c) at the EU threshold, T. The test is formulated as follows:

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

I normalize the estimated costs with respect to the threshold, as follows:

$$NES_p = \frac{estimated\ cost_p - threshold_p}{threshold_p}$$

The normalized estimated cost of procurement is zero at the threshold. I calculate the manipulation test statistic with respect to the normalized threshold value of zero. Figure 4 shows the distribution of NES_p with respect to the thresholds for two sample authorities: nonbunching and bunching.



Sample Nonmanipulative Authority (Authority no:2903) Sample Manipulative Authority (Authority no:3922)

Figure 4: Regression Discontinuity Plots of Sample Nonbunching and Bunching Authorities

Figure 4 presents the intuition behind the manipulation test. The estimated cost is continuous in the first part of the graph for a manipulative 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 the estimated costs shows that the probability of manipulation is significantly high for the authority in the second part of Figure 4.

The R and Stata codes for the regression discontinuity tests are available at https://rdpackages.github.io/.

Data

EU PP data are available as part of the TED data set. The TED data are publicly available online for the period 2006-2017. I use the contract award notices csv files. The files are available at https://data.europa.eu/euodp/data/dataset/ted-csv. The EU extracts the data from the contract notice and contract award notice standard forms submitted by authorities. The standard forms of the EU are available at http://simap.ted.europa.eu/web/simap/standard-forms-for-public-procurement.

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 include variables on estimated cost, contract price, detailed CPV code of the subject of procurement, procurement method, types of contracting authorities, and the 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. The estimated cost is available for 2,056,104 contracts. I use the name and city of each authority to identify individual contracting entities. I identify 92,297 authorities from 30 countries. Figure 5 shows the distribution of the total number of contracts by authority; 91% of the authorities conduct fewer than 30 tenders.

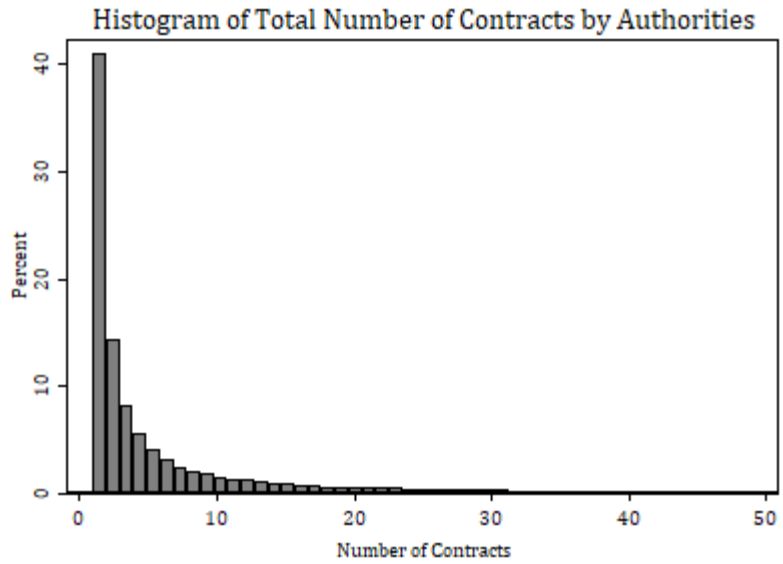


Figure 5: Histogram of Total Number of Contracts by Each Authority.
Number of contracts larger than 50 are not displayed.

A vital component of manipulation testing is the bandwidth around the threshold. The choice of bandwidth determines the observations near the cutoff used to calculate the test statistic. The manipulation test requires adequate number of observations in bandwidths. Accordingly, I employ two alternative criteria to select the authorities for the manipulation analysis. I analyze authorities with more than 20 or 30 observations in the bandwidth, yielding 2,044 and 1,416 authorities, respectively. After eliminating authorities with insufficient numbers of contracts, I examine 408,873 and 326,425 contracts conducted by 2,044 and 1,416 authorities, respectively.

Authorities implement the competitive "open" procedure for 86% of contracts. The remaining contracts are awarded using "award without prior publication of a contract notice" and negotiation procedures. Additionally, the TED data set provides information about the type of contracting authority, that is, whether it is a ministry or federal authority and a regional or a local authority. I employ 10 authority-type dummy variables to control for authority-specific characteristics.

Data availability

The data set used in the paper is publicly available. The data set can be downloaded at https://data.europa.eu/euodp/en/data/dataset/ted-csv. The European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs maintains the integrity of the data set.

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Competing interests

The author declares no competing interests.

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Previous version of the paper is available online as a working paper in the European University Institute RSCAS working paper series with number EUI RSCAS: 2019/17 with the title "Bunching Below Thresholds to Manipulate Public Procurement".
Available online at: https://cadmus.eui.eu/handle/1814/61366

Author contributions

As the single author of the paper, Dr. Tas conducted all the empirical analysis and wrote the paper.

Figures

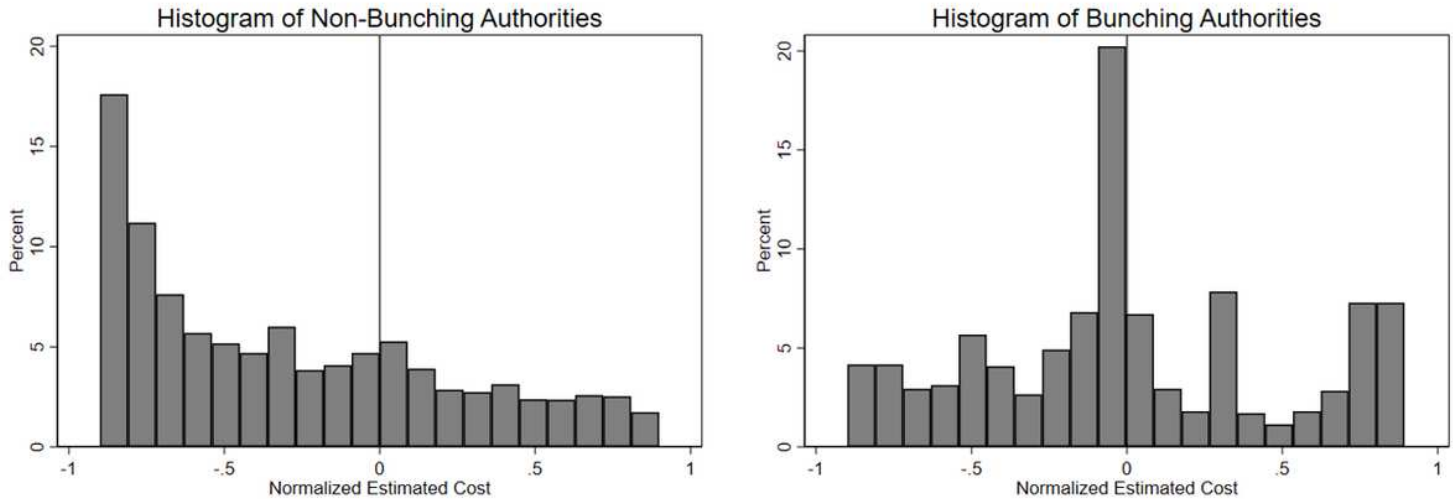

Figure 1

Normalized Estimated Costs of Nonbunching and Bunching Authorities

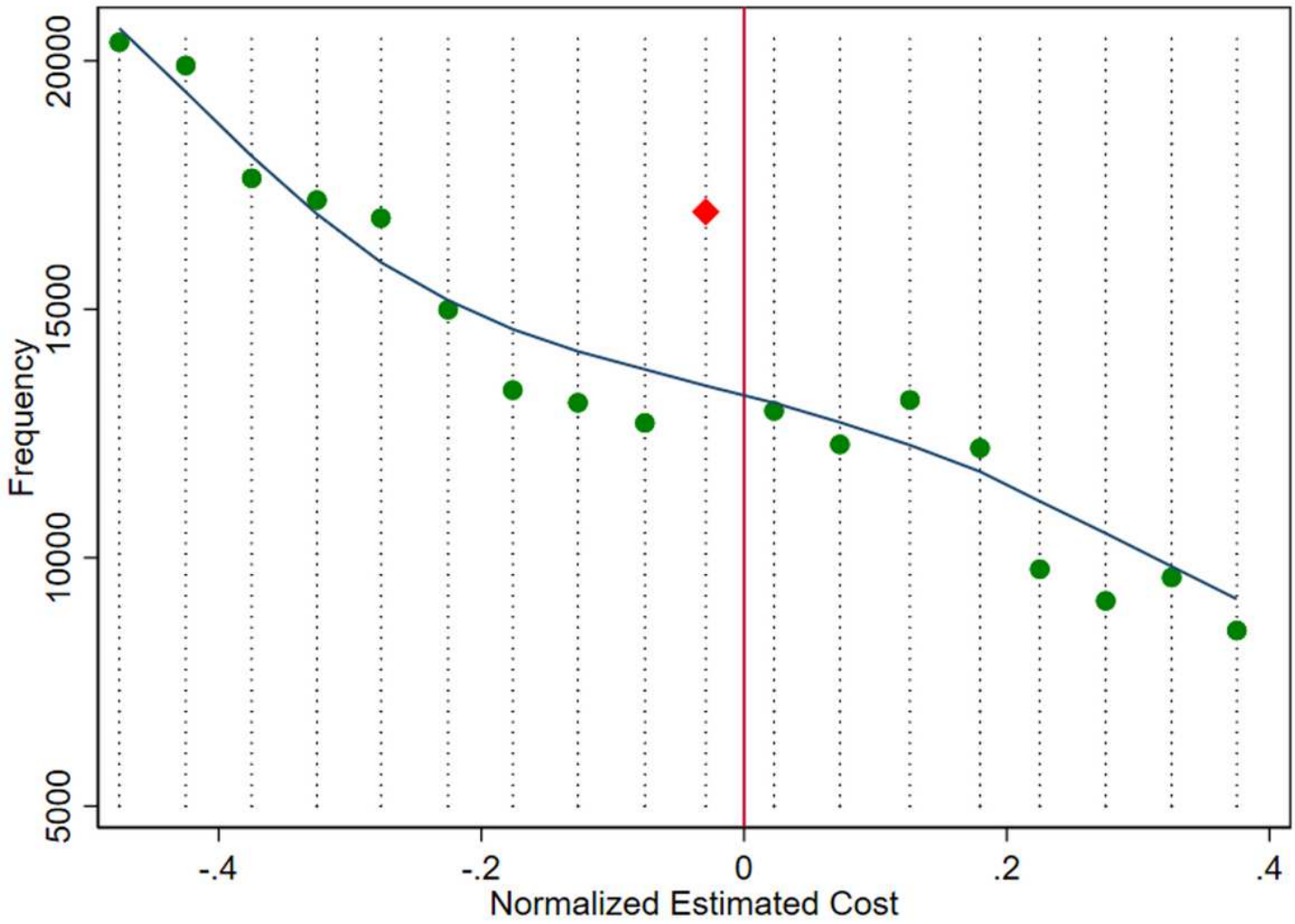

Figure 2

Distribution of Total Number of Contracts with Respect to Normalized Estimated Cost. The figure displays 20 brackets around the threshold. The red diamond presents the bracket just below the threshold, [-0.05, 0].

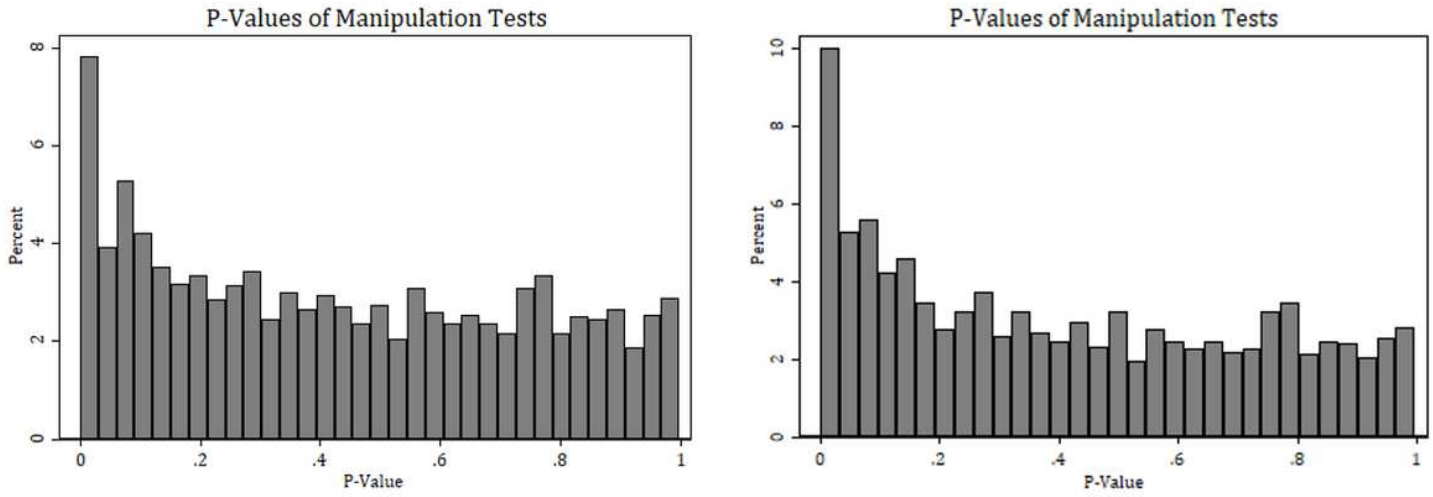

Figure 3

Histograms of Manipulation Test P-Values. (left) 2,044 authorities with more than 20 observations. (right) 1,416 authorities with more than 30 observations.

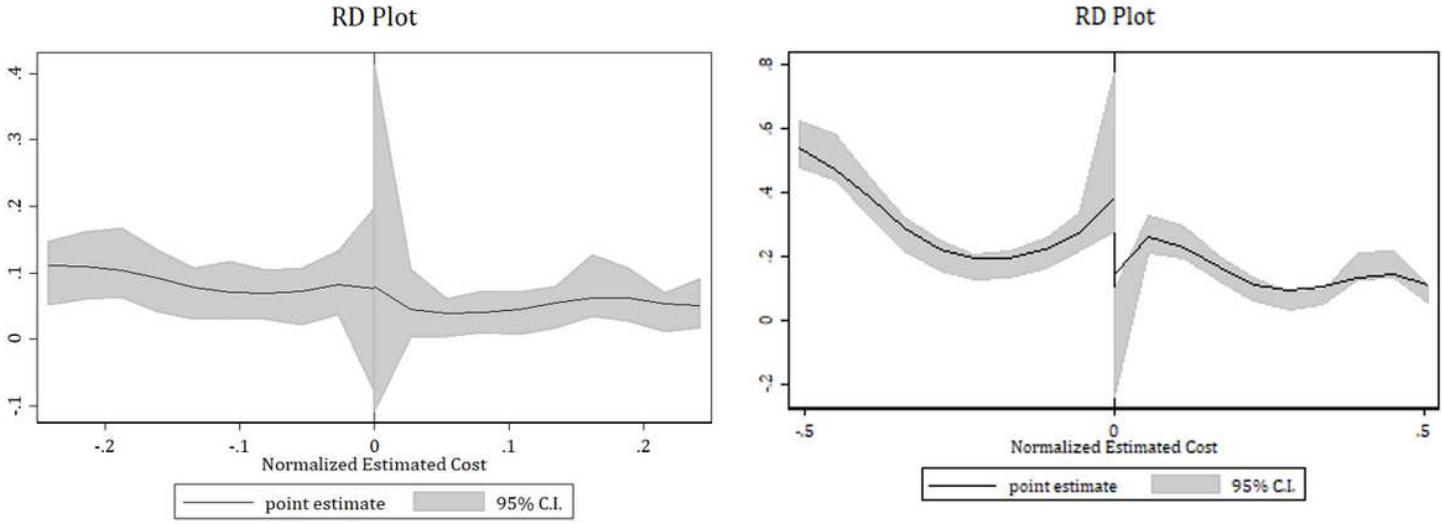

Figure 4

Regression Discontinuity Plots of Sample Nonbunching and Bunching Authorities. (left) Sample Nonmanipulative Authority (Authority no:2903) (right) Sample Manipulative Authority (Authority no:3922)

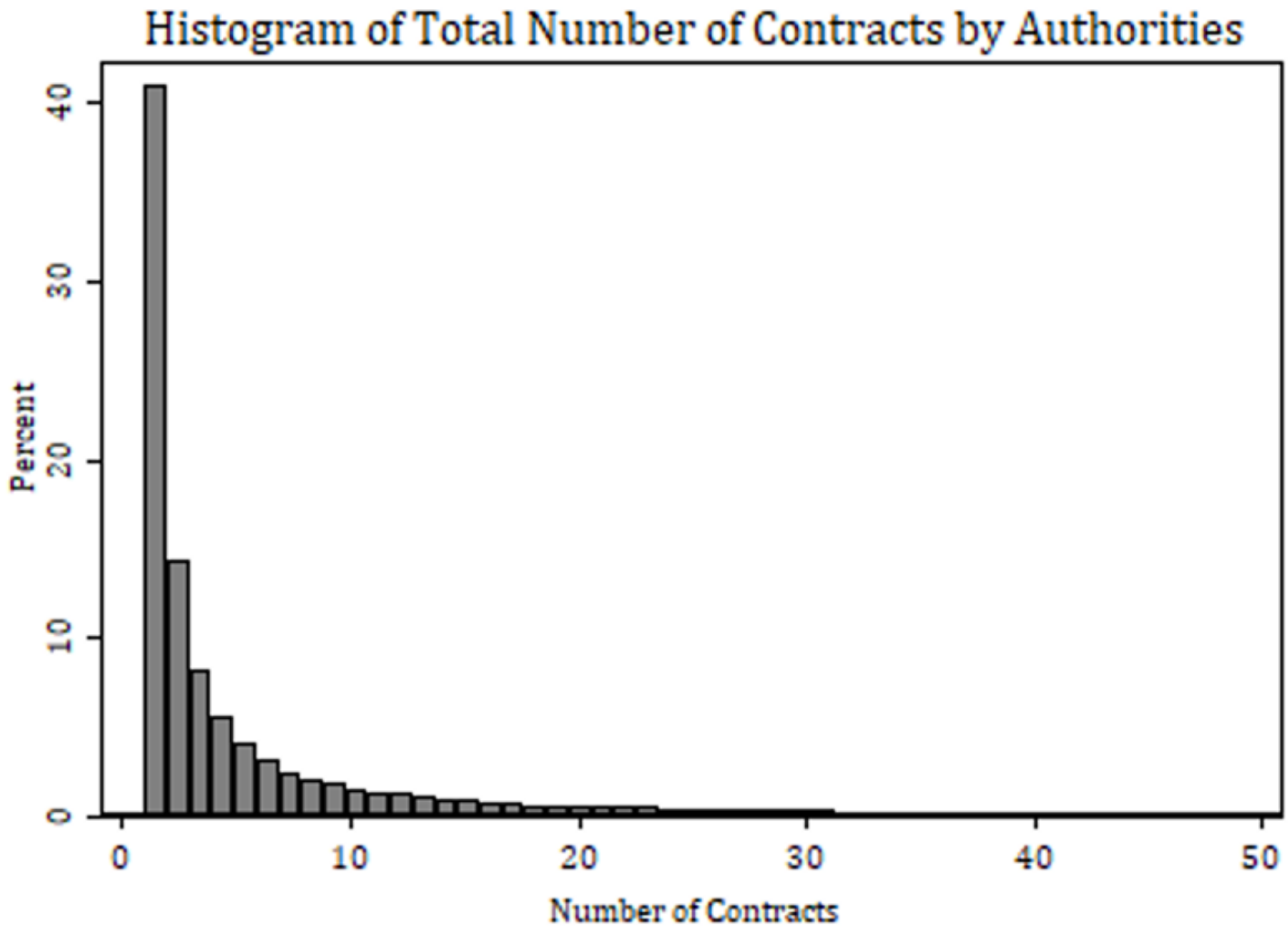

Figure 5

Histogram of Total Number of Contracts by Each Authority. Number of contracts larger than 50 are not displayed.