Public Procurement Auctions with Bidder Preselection: Collusion by Exclusion?

Regina Seibel   &   Samuel Škoda

October 14, 2020

Motivation

- Public authorities in the EU spend around 14 % of GDP on the purchase of services, works and supplies ($\approx €$ 2 trillion per year)
- Bid rigging and collusion considered major threat to efficient procurement process [OECD, 2012]
- However, we have little empirical evidence about which procurement design elements facilitate or prevent bid rigging. Exceptions are:
  - Open auctions are more prone to collusion than sealed-bid auctions [Athey et al., 2011]
  - Minimum prices make it harder to collude [Chassang and Ortner, 2019]
- One variation often observed in practice: Limiting the number of tender participants, referred to as **Preselection**

Motivation

Preselection may be used because

- Procurement agencies want to limit the cost of processing the bids in the main tender
- With discretion: Agencies may have private information relevant to the tender (see literature)
- Without discretion: May be efficiency-enhancing if entry is endogenous (see literature)

Can a bid-rigging cartel exploit preselection rules?

Literature and Contribution
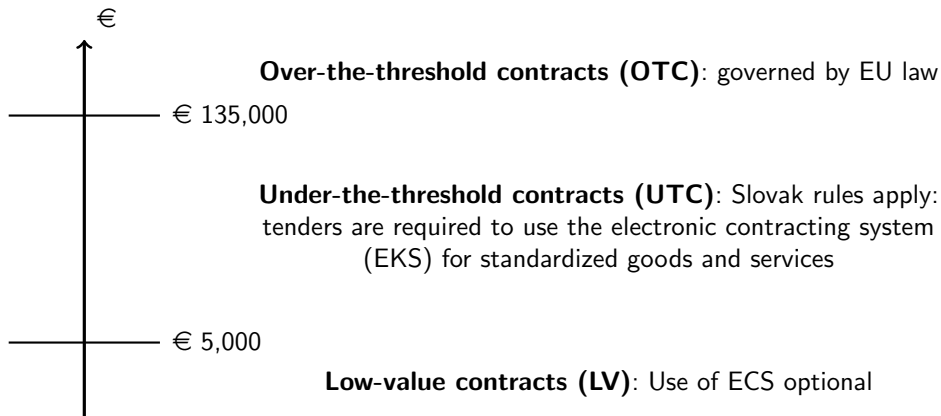
Empirical literature:

- Collusion: Detection of bid rigging in public procurement
  - by suspicious bidding behavior [Porter and Zona, 1993, Bajari and Ye, 2003]
  - by using machine-learning techniques [Huber and Imhof, 2019, Chassang et al., 2020]
  - by comparison of different auction designs [Athey et al., 2011, Chassang and Ortner, 2019]
- Discretion in public procurement [Coviello et al., 2018, Palguta and Pertold, 2017, Spagnolo, 2012]
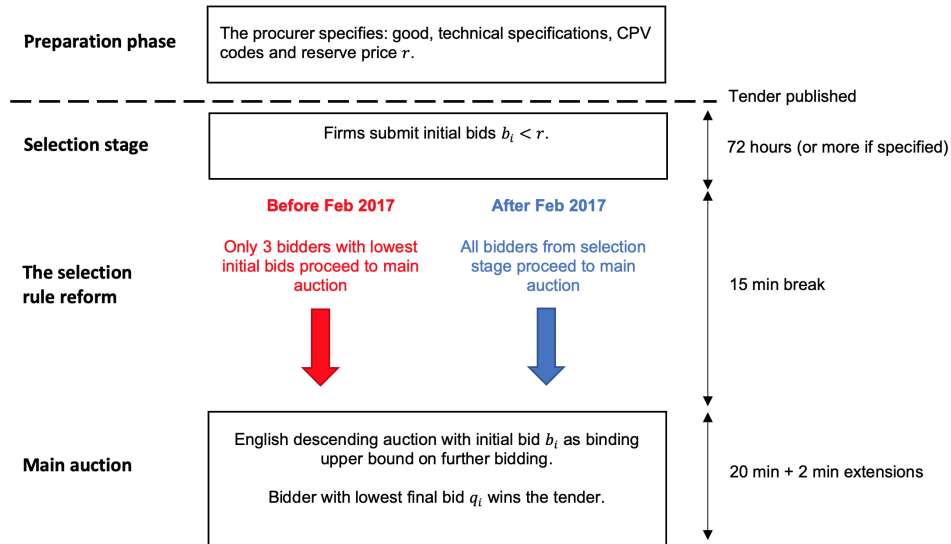
Theoretical literature:

- Revenues of two-stage auctions *(preselection)* compared to one-stage auctions *(no preselection)* [Lu and Ye, 2014, Bhattacharya et al., 2014, Sweeting and Bhattacharya, 2015]
- Effect of auction design on collusive bidding
  [Fabra, 2003, Marshall and Marx, 2007, Chassang and Ortner, 2019]

Our contribution: Documenting novel collusive bidding behaviour in auctions with preselection by exploiting a sudden policy change to a design without preselection

Slovakia: Institutional Background

€

Over-the-threshold contracts (OTC): governed by EU law

— € 135,000

Under-the-threshold contracts (UTC): Slovak rules apply:
tenders are required to use the electronic contracting system
(EKS) for standardized goods and services

— € 5,000

Low-value contracts (LV): Use of ECS optional

E-Public Procurement Auctions in Slovakia

Preparation phase — The procurer specifies: good, technical specifications, CPV codes and reserve price r.

Tender published

Selection stage — Firms submit initial bids $b_i < r$.

72 hours (or more if specified)

The selection rule reform

Before Feb 2017 — Only 3 bidders with lowest initial bids proceed to main auction

After Feb 2017 — All bidders from selection stage proceed to main auction

15 min break

Main auction — English descending auction with initial bid b_i as binding upper bound on further bidding.

Bidder with lowest final bid q_i wins the tender.

20 min + 2 min extensions

Theoretical Predictions - Effect of the Reform

If there is **no cartel**, the reform has no effect on the lowest final bid and thus savings

- Basically, the revenue-equivalence theorem holds
- Equilibrium savings with preselection = equilibrium savings without preselection
- Note: This does not mean that bidding in selection stage vs. main auction is unaffected

If there is a **cartel**, the reform in expectation decreases the lowest final bid and increases savings

- A partial cartel facing competitive rivals can exploit preselection rules to exclude those rivals
- Such a strategy doesn't work anymore if there is no preselection

Theoretical Predictions - Cartel Strategy with Preselection

Collusive exclusion:

With preselection, cartel members should bid very close to each other in the selection stage

Why?

- In the cartel, there is one predetermined winner
- Bidding close to her but not below increases the chance that the cartels gets selected as a whole group
- If the rule selects cartel members only, the cartel has effectivley eliminated competition and no further bidding takes place in the main auction
- NOTE: This is different from what is usually expected and used as behavioral collusion screen `Overview on Screens`

Data

We have the universe of public procurement auctions published on ECS:

- January 2015 - January 2020
- > 6.000 distinct bidders, of which ≈ 4500 won at least one auction
- > 3.000 procurement agencies from 1.300 different municipalities in Slovakia

Analysis

- Let us define the set of bidders participating in auction a as I_a
- To be able to compare bids across auctions a, we normalize the bids submitted in either stage $k \in \{1, 2\}$:

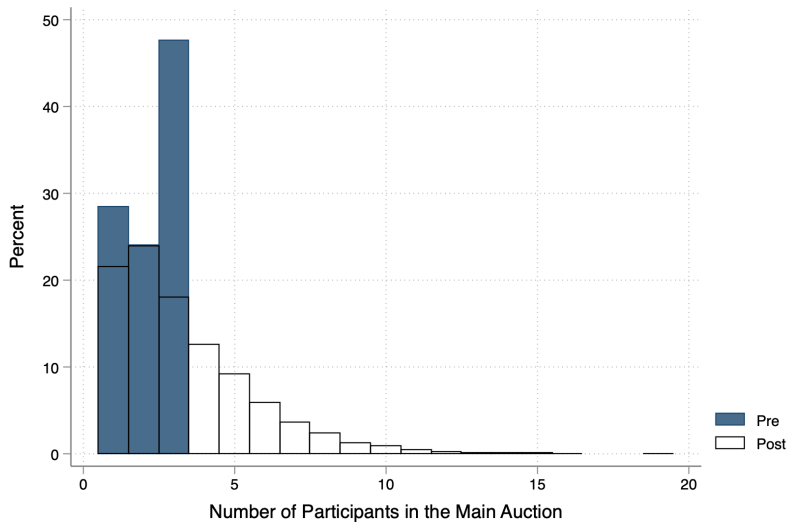$$b_{i,a}^k = \frac{\text{Absolute Bid}_i^k}{\text{Reserve Price}_a}$$

- Thus, relative savings in auction a are given by
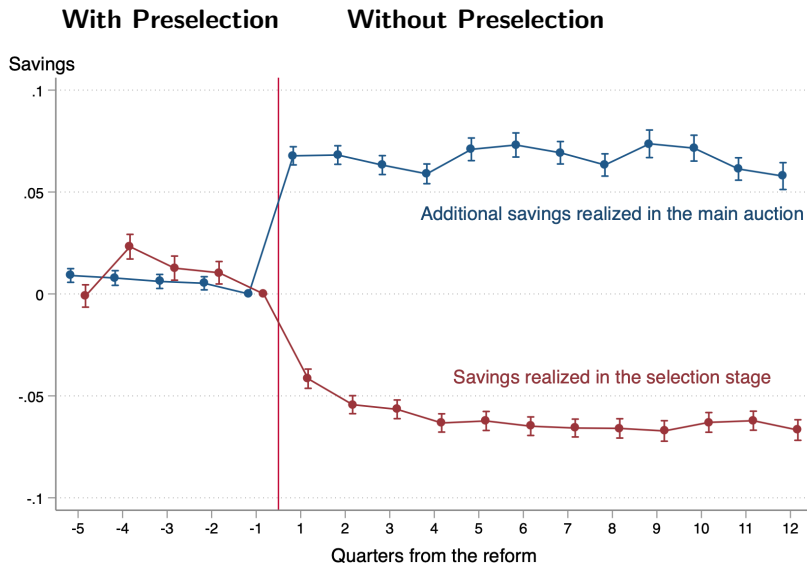
$$s_a = 1 - \min_{i \in I_a} b_{i,a}^2$$

- Sometimes, we are interested in savings based on the lowest initial bids in $k = 1$ and the incremental savings due to bidding in the main auction $k = 2$:

$$s_a^1 = 1 - \min_{i \in I_a} b_{i,a}^1 \qquad s_a^2 = s_a - s_a^1$$

Mechanical Effect of the Reform

Illustrating the Shift in Competition

With Preselection   Without Preselection

Additional savings realized in the main auction

Savings realized in the selection stage

Savings

Quarters from the reform

Defining Collusive Bidders based on Bidding before the Reform

Step 1: With preselection, cartel members should bid closely to be able to exclude rivals

- **Close Bidding**: Identify groups of at least 3 firms which submit bids in a value range of 0.1% of the reserve price of each other in the selection stage
  [Robustness: consider 1% and 0.01%]

Step 2: For a meaningful comparison with post-reform data, we need to find a measure based on bidder identities, not auctions

- **Potential Colluders**: Tag firms as potentially collusive, if they frequently participate in close bidding: more than 95% of firms in our sample
  [Robustness: consider 90% and 99%]
- **Potential Collusion**: Tag auctions as subject to collusion pre- and post-reform, if at least one potential colluder participates

Close Bidding

$$Y_{at} = \alpha + \psi CloseBidding_{at} + \beta \#Bidders_{at} + \gamma_t + \delta X_a + \epsilon_{at} \tag{1}$$

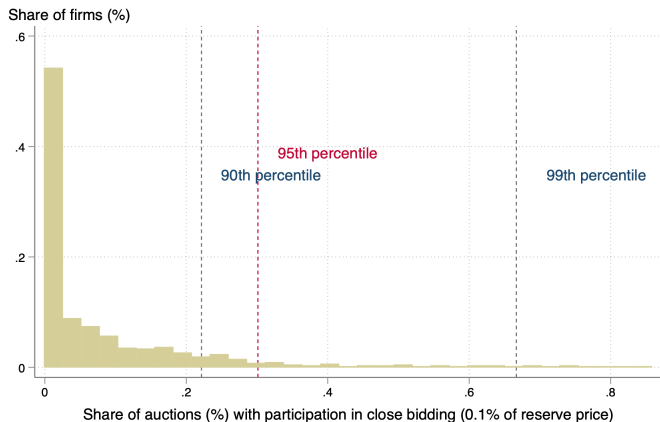|	Competition in Main Auction:			Savings:		
	Active Bidders	#Bids	No bids	Stage 1	Stage 2	Total
# Bidders	0.24***	3.02***	-0.10***	0.04***	0.01***	0.05***
	(0.00)	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)
Close bidding	-0.32***	-3.42**	0.14***	-0.08***	-0.03***	-0.10***
	(0.03)	(1.07)	(0.01)	(0.00)	(0.00)	(0.00)
Avg. Outcome	1.03	13.57	0.51	0.09	0.04	0.13
N	28025	28025	28025	28025	28025	28025

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$\Rightarrow$ Close bidding is correlated with less competition in the main auction

Potential Colluders

- If we assume that cartel membership is somewhat stable over time, cartel members should participate in close bidding groups relatively frequently

Potential Collusion

$$Y_{at} = \alpha + \phi PotentialCollusion_{at} + \beta \#Bidders_{at} + \gamma_t + \delta X_a + \epsilon_{at} \quad (2)$$

	Competition in Main Auction:			Savings:		
	Active Bidders	#Bids	No bids	Stage 1	Stage 2	Total
# Bidders	0.24***	3.06***	-0.10***	0.04***	0.01***	0.04***
	(0.00)	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)
Potential Collusion	-0.41***	-4.75***	0.15***	-0.04***	-0.03***	-0.07***
	(0.03)	(0.78)	(0.01)	(0.00)	(0.00)	(0.00)
Avg. Outcome	1.03	13.57	0.51	0.09	0.04	0.13
N	28025	28025	28025	28025	28025	28025

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$\Rightarrow$ Participation of at least one potential colluder (*Potential Collusion*) in a tender is correlated with less competition in the main auction

$$Savings_{at} = \alpha + \phi_1 PotentialCollusion_{at} + \phi_2 PotentialCollusion_{at} \times Post_t$$
$$+ \beta_1 \#Bidders_{at} + \beta_2 \#Bidders_{at} \times Post_t + \gamma_t + \delta X_a + \epsilon_{at}$$

Concern: $\#Bidders_{at}$ may respond endogenously to reform

Solution: IV using the number of notified contractors as instrument `Notified contractors` `First Stage`

- Public agents have to indicate at least one CPV category when publishing a procurement auction
- Firms can set up automated notification emails when an auction in a subscribed category is published
- Goods categorization allows very finel levels: Ambiguity in which ones to pick

Example: Office machinery, equipment and supplies except computer, printers and furniture $\rightarrow$ Various office equipment and supplies $\rightarrow$ Office supplies $\rightarrow$ Pencil sharpeners

Main Result: Regression

	(1) OLS	(2) IV	(3) OLS	(4) IV
Post	-0.037***	-0.047***	-0.033***	-0.026*
	(0.006)	(0.011)	(0.006)	(0.011)
No. of Bidders × Post	0.011***	0.014***	0.008***	0.007*
	(0.001)	(0.003)	(0.001)	(0.003)
No. of Bidders	0.043***	0.034***	0.044***	0.024***
	(0.000)	(0.002)	(0.001)	(0.005)
Potential Collusion × Post	0.023***	0.010	0.029***	0.019*
	(0.004)	(0.007)	(0.004)	(0.008)
Potential Collusion	-0.071***	-0.051***	-0.066***	-0.026**
	(0.003)	(0.006)	(0.003)	(0.010)
Category	no	no	yes	yes
AvgSavings	0.13	0.13	0.13	0.13
Fstat	.	349.29	.	158.15
N	88290	88266	65440	65418

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Main Result: Regression

	(1) OLS	(2) IV	(3) OLS	(4) IV
Post	-0.037***	-0.047***	-0.033***	-0.026*
	(0.006)	(0.011)	(0.006)	(0.011)
No. of Bidders × Post	0.011***	0.014***	0.008***	0.007*
	(0.001)	(0.003)	(0.001)	(0.003)
No. of Bidders	0.043***	0.034***	0.044***	0.024***
	(0.000)	(0.002)	(0.001)	(0.005)
Potential Collusion × Post	0.023***	0.010	0.029***	0.019*
	(0.004)	(0.007)	(0.004)	(0.008)
Potential Collusion	-0.071***	-0.051***	-0.066***	-0.026**
	(0.003)	(0.006)	(0.003)	(0.010)
Category	no	no	yes	yes
AvgSavings	0.13	0.13	0.13	0.13
Fstat	.	349.29	.	158.15
N	88290	88266	65440	65418

Standard errors in parentheses
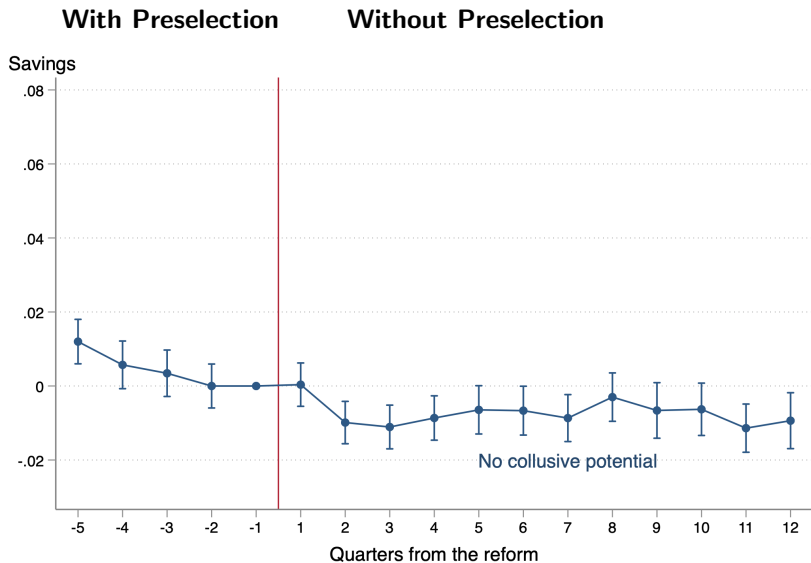
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Main Result

With Preselection   **Without Preselection**

Savings

No collusive potential

Quarters from the reform

Main Result

Conclusion and Next Steps

Cartels can exploit preselection rules and thereby decrease savings below what would be possible without preselection

Next steps:

- Refine collusion measure: keep track of groups of firms which frequently bid close to each other
- Look into one market in more detail: Lunch Voucher Cartel
    - This is a full cartel in most periods, but sometimes there are new entrants or firms from close sectors trying to compete
    - Does the cartel apply a Collusion-by-Exclusion strategy? How does the strategy change after the reform?

References I

Athey, S., Levin, J., and Seira, E. (2011).
Comparing open and sealed bid auctions: Evidence from timber auctions.
The Quarterly Journal of Economics, 126(1):207–257.

Bajari, P. and Ye, L. (2003).
Deciding between competition and collusion.
Review of Economics and Statistics, 85(4):971–989.

Bhattacharya, V., Roberts, J. W., and Sweeting, A. (2014).
Regulating bidder participation in auctions.
The RAND Journal of Economics, 45(4):675–704.

Chassang, S., Kawai, K., Nakabayashi, J., and Ortner, J. (2020).
Data driven antitrust: Theory and application to missing bids.
Technical report, Working Paper.

Chassang, S. and Ortner, J. (2019).
Collusion in auctions with constrained bids: Theory and evidence from public procurement.
Journal of Political Economy, 127(5):2269–2300.

Coviello, D., Guglielmo, A., and Spagnolo, G. (2018).
The effect of discretion on procurement performance.
Management Science, 64(2):715–738.

References II

Fabra, N. (2003).
Tacit collusion in repeated auctions: uniform versus discriminatory.
The Journal of Industrial Economics, 51(3):271–293.

Harrington, J. (2008).
Handbook of antitrust economics. chapter detecting cartels.

Huber, M. and Imhof, D. (2019).
Machine learning with screens for detecting bid-rigging cartels.
International Journal of Industrial Organization, 65:277–301.

Lu, J. and Ye, L. (2014).
Optimal two-stage auctions with costly information acquisition.
Ohio State University Discussion paper.

Marshall, R. C. and Marx, L. M. (2007).
Bidder collusion.
Journal of Economic Theory, 133(1):374–402.

OECD (2012).
Recommendation of the oecd council on on fighting bid rigging in public procurement.
Technical report.

References III

Palguta, J. and Pertold, F. (2017).
Manipulation of procurement contracts: Evidence from the introduction of discretionary thresholds.
American Economic Journal: Economic Policy, 9(2):293–315.

Porter, R. H. and Zona, J. D. (1993).
Detection of bid rigging in procurement auctions.
Journal of political economy, 101(3):518–538.

Spagnolo, G. (2012).
Reputation, competition, and entry in procurement.
International Journal of Industrial Organization, 30(3):291–296.

Sweeting, A. and Bhattacharya, V. (2015).
Selective entry and auction design.
International Journal of Industrial Organization, 43:189–207.

Appendix

Why Slovakia?

Well first, we can get the data, but also:

- Attractive data: the system reliably tracks the identity of procurer and bidder and is one of the most transparent
- Comparable to other European countries according to indicators based on different public procurement aspects (competitiveness, transparency, SME inclusion)

Back

2. Overall performance
(all 12 indicators combined)

Leaflet | Credit: EC-GISCO, © EuroGeographics © UN-FAO for the administrative boundaries

1

---

[1]`https://ec.europa.eu/internal_market/scoreboard/_docs/2019/performance_per_policy_area/public_procurement_en.pdf`

Collusion Screens

Structural Screens [Harrington, 2008]:

- Identify MARKETS which are more conducive to collusion, i.e. collusion more likely with fewer firms, more homogenous products, more stable demand

Behavioral Screens: Identify BIDDERS by suspicious bidding behavior or coordination

- Usually collusion is considered to work in the following way, see [Porter and Zona, 1993, Bajari and Ye, 2003]:
    - A cartel determines internally who is the member with the lowest bid and then only this member submits a serious bid
    - The others either refrain form participation or submit 'phony' bids, high bids which should just pretend to be competitive to avoid detection
- More recently this observation is also resulting form applying machine learning techniques [Huber and Imhof, 2019, Chassang et al., 2020]

$\Rightarrow$ We show that for some auctions, exactly the opposite is indicative for collusive behavior

Back to Predictions

Example and Mechanism

Let us consider examples on which reaction to the policy change we expect with competition versus (partial) collusion:

- Suppose we have 3 bidders
- For simplification consider independent private values and abstract from any signalling through bids
- Bidders know their own costs, but not the costs of the others, costs are independently distributed on $[0, 120]$
- In the first stage, reverse first-price sealed bid auction in the sense that the lowest bidder is the "preliminary winner"
- The second stage is a reverse English auction, thus each bidder is willing to bid down to their costs, but not below and the winner pays the second-lowest bid
- In the bidder selection case, the 2 lowest-price bidders from the first stage are allowed to proceed to the second stage

- The maximum price at which the procurer is willing to buy is 150
- First-stage bids need to be monotone in a symmetric equilibrium (if $r > \bar{c}$)

With bidder selection (Pre):

Bidder	Cost	Initial bid	Selected	Final bid
Bidder 1	100	$b_1 = 135$	✓	100
Bidder 2	110	$b_2 = 140$	–	–
Bidder 3	85	$b_3 = 125$	✓	$100 - \epsilon$

preliminary
winner

- The maximum price at which the procurer is willing to buy is 150
- First-stage bids need to be monotone in a symmetric equilibrium (if $r > \bar{c}$)

With bidder selection (Pre):

Bidder	Cost	Initial bid	Selected	Final bid
Bidder 1	100	$b_1 = 135$	$\checkmark$	100
Bidder 2	110	$b_2 = 140$	$-$	$-$
Bidder 3	85	$b_3 = 125$	$\checkmark$	$100 - \epsilon$

Savings: $50 + \epsilon$

- The maximum price at which the procurer is willing to buy is 150

Without bidder selection (Post):

Bidder	Cost	Initial bid	Selected	Final bid
Bidder 1	100	150	✓	100
Bidder 2	110	150	✓	110
Bidder 3	85	150	✓	$100 - \epsilon$

Savings: $50 + \epsilon$

Bidding under Collusion

- Now suppose bidders 2 and 3 form a cartel
- They internally learn their costs and know that bidder 3 will win
- We assume that there is a system of compensation within the cartel in place

With bidder selection (Pre):

Bidder	Cost	Initial bid	Selected	Final bid
Bidder 1	100	$b_1 = 135$	–	–
Bidder 2	110	$c_2 = 125 + \epsilon$	✓	$125 + \epsilon$
Bidder 3	85	$b_3 = 125$	✓	125

Savings: 25

Bidding under Collusion

- Now suppose bidders 2 and 3 form a cartel
- They internally learn their costs and know that bidder 3 will win
- We assume that there is a system of compensation within the cartel in place

Without bidder selection (Post):

Bidder	Cost	Initial bid	Selected	Final bid
Bidder 1	100	150	✓	100
Bidder 2	110	150	✓	150
Bidder 3	85	150	✓	$100 - \epsilon$

Savings: $50 + \epsilon$

Back to Predictions

Summary Statistics: +/- three Months around Reform

	(1) Pre N	(2) Mean	(3) SD	(4) Post N	(5) Mean	(6) SD
VARIABLES						
prelim_winning_bid	8,347	0.91	0.14	7,749	0.96	0.10
winning_bid	8,347	0.88	0.16	7,749	0.86	0.18
bidders_total	8,347	3.00	2.16	7,749	3.29	2.20
offers_total	8,347	17.68	37.55	7,749	35.47	61.57
notified_contractors	8,347	436.93	219.49	7,747	448.36	226.00
participants_stage2	8,347	2.19	0.85	7,749	3.29	2.20
bidders_stage2	8,347	0.99	1.12	7,749	1.85	1.64
savings	8,347	0.12	0.16	7,749	0.14	0.18
max_resource	8,347	11,718.91	29,186.74	7,749	13,036.62	31,712.44
same_ranking	8,347	0.79	0.41	7,749	0.55	0.50
same_win_bid	6,586	0.66	0.47	4,235	0.59	0.49

Back to Analysis

IV First Stage Results

	(1)	(2)	(3)	(4)
	No. of Bidders	Post × No. of Bidders	No. of Bidders	Post × No. of Bidders
Notified contractors	0.001***	-0.000***	0.002***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Notified × Post	-0.001***	0.001***	0.000	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Potential Collusion× Post	-0.633***	1.531***	-0.558***	1.527***
	(0.059)	(0.033)	(0.067)	(0.040)
Potential Collusion	2.071***	-0.090***	1.909***	-0.135***
	(0.050)	(0.009)	(0.057)	(0.011)
Month	yes	yes	yes	yes
Year	yes	yes	yes	yes
Category	no	no	yes	yes
Procurer	yes	yes	yes	yes
AvgSavings	0.13	0.13	0.13	0.13
Fstat	476.04	411.39	159.21	853.55
N	88266	88266	65418	65418

Standard errors in parentheses

$* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$

Back to IV

Notified contractors

Notified contractors
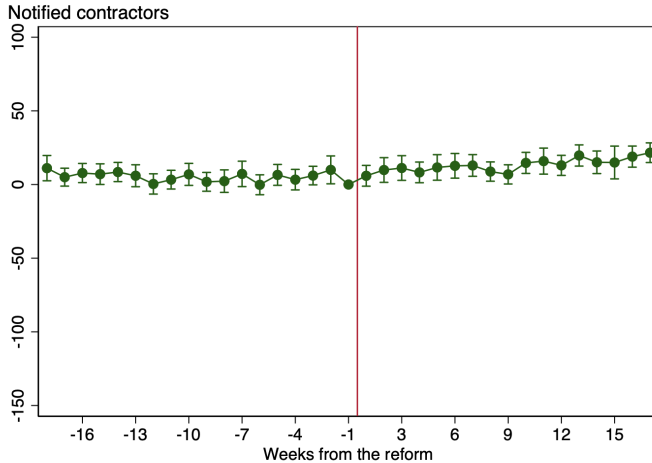
At least two collusive bidders

	Competition in Stage 2:			Savings:		
	Active Bidders	# Bids	No bids	Stage 1	Stage 2	Total
# Bidders	0.24***	3.01***	-0.10***	0.04***	0.01***	0.04***
	(0.00)	(0.11)	(0.00)	(0.00)	(0.00)	(0.00)
2+ potential colluders	-0.64***	-5.80***	0.27***	-0.06***	-0.03***	-0.10***
	(0.04)	(1.23)	(0.02)	(0.00)	(0.00)	(0.00)
Avg. Outcome	1.03	13.57	0.51	0.09	0.04	0.13
N	28025	28025	28025	28025	28025	28025

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

At least three collusive bidders

	Competition in Stage 2:			Savings:		
	Active Bidders	#Bids	No bids	Stage 1	Stage 2	Total
# Bidders	0.24***	3.06***	-0.10***	0.04***	0.01***	0.04***
	(0.00)	(0.11)	(0.00)	(0.00)	(0.00)	(0.00)
3+ potential	-1.00***	-13.04***	0.42***	-0.07***	-0.04***	-0.11***
colluders	(0.06)	(1.43)	(0.03)	(0.01)	(0.00)	(0.01)
Avg. Outcome	1.03	13.57	0.51	0.09	0.04	0.13
N	28025	28025	28025	28025	28025	28025

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$