

Using the Moran's I to Detect Bid Rigging in Brazilian Procurement Auctions

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Summary

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Introduction

Motivation

- Public procurement accounts for an estimated 15% of GDP worldwide on average (OECD ,2009) and the cartel overcharges by approximately 16% (Boyer and Kotchoni, 2015).
- Thus, Bid Rigging schemes can roughly result in economic losses of approximately 2.3% of GDP in the public sector budget.
- Consequences: reduction in economic welfare, reduction in competition and reduce incentives for innovations.

Introduction

Motivation

- The detection of and fight against bid-rigging cartels has become a priority of antitrust authorities and anti-corruption agencies around the world.
- Relative to detection, public authorities may act in a reactive or proactive way. Rise of Leniency Programs.
- Leniency agreements have the limitation of detecting only those cartels that are unstable and are close to breaking points such that successful cartels remain unscathed (Abrantes-Metz and Bajari, 2012).
- An example of a proactive practice is the use of economic screens.

Introduction

Objectives

- We propose an economic screen based on Moran's I statistic that identifies the systematic correlation between bids to investigate the behaviour of a bid-rigging cartel (Lundberg, 2017).
- The proposed screen is applied to a supposed bid-rigging cartel that operates in the implantable cardiac device (ICD) market in Brazil. This bid-rigging scheme is being investigated by the CADE.
- According to the investigative process, the cartel operated between 2004 and 2015 and comprised a group of four companies, twenty-nine individuals and two industrial associations.

Introduction

Literature

- Variance Screen: exchange in information and bid coordination truncates the distribution of bids values (Imhof 2018; Abrantes-Metz et al. 2006).
- Interdependence of Bids: in sealed auctions, it is expected that the bids will be independent of each other after the control of the observed information (Bajari and Ye 2003; Aryal and Gabrielli 2013; Lundberg 2017).
- Rotation of Winners: artificial exchange of the winning bidder in procurement auctions that are frequently conducted (Ishii 2009; Imhof et al. 2018).

Introduction

Contributions

- We intend to contribute in two ways: I) Applying a methodology that allows one to test the conditional independence hypothesis in a more flexible manner in relation to previous studies and II) Analysing the behaviour of an investigated bid-rigging cartel that operated in the Brazilian market for implantable cardiac devices using a novel and public database.
- In Brazil, most of the screens have been applied to detect price-fixing cartels operating in the fuel station sector (see, for example, Ragazzo and Silva 2006; Vasconcelos and Vasconcelos, 2005).

Institutional Background

Description of the supposed bid-rigging cartel

- To evaluate the suitability of the screen based on Moran's I statistic, we will analyse a supposed bid-rigging scheme that operated in the Brazilian market for implantable cardiac devices (ICD).
- January 2015: the Ministry of Health made a set of complaints pointing to fraud involving ICD suppliers.
- After the complaint, CADE and MPF began investigating the case and, in addition, two Parliamentary Inquiry Committees were opened.
- November 2015: an involved company signed a partial leniency agreement with CADE confessing to the bid-rigging scheme in the ICD market and committing to cooperate with the investigations.

Institutional Background

Description of the supposed bid-rigging cartel

G1 ECONOMIA

Cade investigará cartel de fabricantes de marca-passo e cateter

Conselho abriu dois processos para apurar combinação de preço no mercado de órteses, próteses e materiais médicos especiais.

Por Luis Lás, G1
21/09/2017 13:58 - Atualizado há 2 anos

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PIAUI A REVISTA RÁDIO PIAUI ESPECIALS HERALD LIPA EVENTOS ASSINE

anais da saúde pública

POR DENTRO DO CARTEL DOS IMPLANTES

Relatórios sigilosos revelam como a maior fabricante mundial de dispositivos cardíacos fraudou licitações e estimulou cirurgias desnecessárias no Brasil durante 20 anos

ALLAN DE ABREU
25nov2010_12h52

FANTÁSTICO

Edição de 04/03/2013
9431215 2308 - Atualizado em 95012915 2769

Máfia das próteses coloca vidas em risco com cirurgias desnecessárias

Médicos chegam a faturar R\$ 100 mil por mês em esquema que desvia dinheiro do SUS e encarece planos de saúde.

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VOCE ESTÁ AQUI: PÁGINA INICIAL > NOTÍCIAS > SUPERINTENDÊNCIA INSTAURA PROCESSOS PARA APURAR CARTEL NO MERCADO DE ÓRTESES, PRÓTESES E MATERIAIS MÉDICOS ESPECIAIS

ASSUNTOS

- Processos
- Serôsides
- Normas e legislação
- Internacional
- Programa de Leilões

NOTÍCIAS

Superintendência instaura processos para apurar cartel no mercado de órteses, próteses e materiais médicos especiais

Cade

Acusados serão notificados para apresentar suas defesas

Institutional Background

Description of the supposed bid-rigging cartel

- According to the administrative process, the bid-rigging scheme operated in Brazil from 2004 to 2015 and was operated by the four largest companies in the ICD market (CADE 2017).
- The scheme was coordinated through face-to-face meetings involving company directors and, in some situations, was intermediated by industry associations.
- The anticompetitive practices that were investigated are the following: the exchange of price information, supply agreements, customer allocations between competitors and combinations of proposals in the sealed bidding phase.

Institutional Background

Auctions Rules in ICD Markets

- The public procurement auctions that were created for the purchase of ICD items are mostly carried out electronically and are governed by the rules of Law 5.450/2005. The auctions take place in two different stages.
- In the first stage, each of the competitors makes their bid by delivering a sealed envelope with the bid value to the auction organizer, and it functions as a sealed-bid auction.
- Following the opening of the envelopes, the second stage starts with a downward oral auction (with simultaneous bids) starting with the bid values that were made by the bidders in the first stage.

Institutional Background

Auctions Rules in ICD Markets

- Coordinating first-stage bids makes it possible to establish a larger starting point for the second stage and avoids offering low-value bids.
- This potentially favours a higher contract price than that in the case of competition and facilitates the direction of the acquisition process.
- Our screening method seeks to capture possible bid coordination in the first stage of an electronic procurement auction, which could be an indication of a broader collusive agreement.

Methodology

Assumptions

- Initially, it is assumed that there are two types of bidders: those that engage in collusive activities (type A firms) and those that act competitively (type B firms).
- In first-price sealed auctions, type A firms place complementary bids while the bids that are placed by type B firms and across type A and type B firms tend to be independent.
- We denote b_{ic} as the bid value that is placed by firm i on contract c , n_a is the number of bids that is placed by type A companies and n_b is the number of bids that is placed by type B companies.

Methodology

Bidding Matrix

- We define the **bidding matrix** as a matrix W of dimension $n \times n$ with elements $w_{ic,jc}$ such that $w_{ic,jc} > 0$ if $i \neq j$ and $i, j \in A$. Otherwise $w_{ic,jc} = 0$.
- It is observed that the bids are independent across the different contracts ($w_{ic,jk} = 0$ if $c \neq k$) and independent between the set of non-collusive bidders ($w_{ic,jc} = 0$ if $i \in B$ or/and $j \in B$).
- Finally, the magnitude of matrix weights is defined as follows: $w_{ic,jc} = 1/(N_{AC} - 1)$, where N_{AC} is the number of type A firms participating in the auction for contract C . This adjustment allows us to obtain a row standardized matrix.

Methodology

Bidding Matrix - A simple example

- Suppose a contract in which three firms participate (1,2 and 3) and it is suspected that the first two are engaged in a collusive agreement (belong to group A). This would be our bidding matrix:

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

- To detect complementary bidding behaviour the next step is to calculate the global Moran's I statistic, which was developed by Moran (1948) and has been widely used to detect the existence of spatial autocorrelation:

$$I = \frac{\sum_i \sum_j w_{ic,jc} (b_{ij} - \mu)(b_{jc} - \mu)}{\sum_i (b_{ic} - \mu)^2}$$

- Under the hypothesis of the absence of autocorrelation, it is possible to demonstrate that the expectation of Moran's I statistic is given by $E(I) = -1/(N - 1)$, and it tends to zero to the extent that $N \rightarrow \infty$.
- The value of Moran's I statistic ranges from -1 to $+1$.

Methodology

Bid Regressions

- The problem with this approach is that bids may be autocorrelated in sealed auctions due to natural market factors that are not necessarily related to collusive behaviour.
- We estimate a bid regression to generate b_{ic} free from the influence of market variables. In this sense, we apply Moran's I statistic to the residuals of the following bid regression:

$$b_{ic} = \gamma X_{ic} + \theta_s + \lambda_p + \mu_i + \varepsilon_{ic}$$

- When applying Moran's I statistic to the residuals of a bid regression, a potential systematic correlation between the bids can be attributed to other unobservable variables, which include the collusive behaviour.

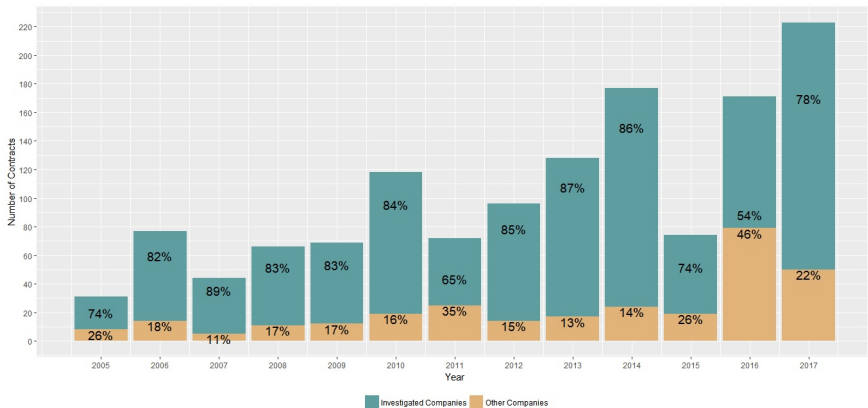
Data and Descriptive Statistics

Data

- The database that is used in the present study is public and was obtained from the Integrated Administration and General Services System (Comprasnet - SIASG). **Projeto Cérebro (CADE)**.
- Considering our objective, we filtered this database to get the information from the procurement auctions of the ICD market involving the participation of at least one of the firms that has been investigated for bid-rigging collusion.
- Dataset containing information on 238 public procurements involving 1351 different contracts and 4679 bids that were submitted by 147 companies in the period from January 2005 to December 2017.

Data and Descriptive Statistics

Figure: Evolution of the Number of Contracts in the ICD market



Data and Descriptive Statistics

Variables Definition

- Dependent variable: ratio between the bid value that is placed in the first stage of an electronic auction and the corresponding bid value that was estimated by the public administration.
- Firm specific controls: capacity rate of firm i (ratio between the number of contracts that are won by the firm up to the date of contract c and the total number of contracts that can be obtained until the end of the year) and number of employees.
- Contract specific controls: number of competitors for contract c and number of ICD items to be contracted through contract c .

Table: Bid Regression for ICD public procurements (2005 to 2017).

	(1)	(2)	(3)
Intercept	0.4192*** (0.048)	0.0729 (0.284)	0.719*** (0.304)
Capacity Rate	-0.0526*** (0.02)	-0.0478*** (0.019)	-0.0386 (0.029)
log (Employees)	-0.073*** (0.006)	-0.0299 (0.028)	-0.0853*** (0.032)
Number of Competitors	0.0239*** (0.008)	-0.0014 (0.008)	0.0196 (0.016)
Number of Itens	-0.0002*** (0.000)	-0.0002*** (0.000)	-0.0002*** (0.000)
ICD Specification FE	No	Yes	Yes
Firm FE	No	Yes	Yes
Procurement FE	No	No	Yes
F-Test	52.37***	12.4***	9.769***
Adjusted R^2	0.042	0.369	0.461
Morans-I Statistic	0.266***	0.380***	0.384***
Number of Observations	4679	4679	4679

Results

Just capturing unobserved market behavior?

Table: Bid Regression for ICD public procurements using different subsamples

	Cartel Period (2005-2015)	Post-Cartel Period (2015-2017)
	(1)	(2)
Intercept	1.9081*** (0.479)	-1.8252*** (0.396)
Capacity Rate	-0.0555 (0.038)	0.0673* (0.040)
log (Employees)	-0.3519*** (0.050)	0.5908*** (0.090)
Number of Competitors	-0.0004 (0.021)	0.0837*** (0.021)
Number of Itens	-0.0004*** (0.000)	-0.0001 (0.000)
ICD Specification FE	Yes	Yes
Firm FE	Yes	Yes
Procurement FE	Yes	Yes
F-Test	8.567***	11.58***
Adjusted R^2	0.4714	0.4782
Morans-I Statistic	0.444***	-0.02263
Number of Observations	3293	1386

Results

Robustness Checks

Table: Bid Regression in post-cartel period: eliminating transitional periods.

	6 months	9 months	12 months
	(1)	(2)	(3)
Intercept	-1.3144** (0.687)	-1.1774 (0.728)	-2.4425 (2.154)
Capacity Rate	0.1727*** (0.058)	0.1752*** (0.060)	0.1904*** (0.068)
log (Employees)	0.3855** (0.198)	0.3381* (0.210)	0.7007 (0.641)
Number of Competitors	0.1265*** (0.023)	0.1323*** (0.024)	0.1435*** (0.027)
Number of Items	-0.0001 (0.000)	-0.0001 (0.000)	-0.0001 (0.000)
ICD Specification FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Procurement FE	Yes	Yes	Yes
F-Test	11.28***	8.01***	7.701***
Adjusted R^2	0.5026	0.4002	0.4067
Morans-I Statistic	0.024	0.021	-0.027
Number of Observations	978	936	734

Results

Robustness Checks - Bajari and Ye (2003)

Table: Pearson and Spearman correlation coefficients of bid residuals

Firms	N. Simultaneous Bids	Pearson Correlation	Spearman Correlation
(1,2)	1045	0.756*** (0.000)	0.486*** (0.000)
(1,3)	711	0.677*** (0.000)	0.572*** (0.000)
(1,4)	399	0.043 (0.390)	0.250*** (0.000)
(2,3)	702	0.684*** (0.000)	0.464*** (0.000)
(2,4)	408	0.226*** (0.000)	0.443*** (0.000)
(3,4)	306	0.165*** (0.004)	0.254*** (0.000)

Results

Robustness Checks - Bergman et al. (2019)

Table: Spatial Bid Regression for ICD public procurements

	Cartel Period (2005-2015)	Post-Cartel Period (2015-2017)
	(1)	(2)
ρ	0.4521*** (0.013)	-0.0343 (0.026)
Intercept	1.5094*** (0.309)	-2.8472*** (0.423)
Capacity Rate	-0.0548** (0.031)	0.0661** (0.038)
log (Employees)	-0.3423*** (0.04)	0.5858*** (0.086)
Number of Competitors	-0.0085 (0.017)	0.0860*** (0.020)
Number of Itens	-0.0003*** (0.000)	-0.0001 (0.000)
ICD Specification FE	Yes	Yes
Firm FE	Yes	Yes
Procurement FE	Yes	Yes
Log-Likelihood	-1672.609	-82.66346
AIC	4127.2	411.33
Number of Observations	3293	1386

Conclusions

- In the present paper, we propose an economic screen that identifies the systematic correlation between bids to investigate the behaviour of an alleged bid-rigging cartel that operates Brazilian ICD market.
- Applying Moran's I statistic to the residuals of the bid regressions, we show that the bids that were placed by the accused companies have systematic autocorrelation in the sealed phase of the electronic auctions, which suggests complementary bidding behaviour.
- Advantages: low data requirements, computational and statistical simplicity and versatility.

Conclusions

- However, Moran's I statistic requires prior knowledge of the identity of the companies that may form the bid-rigging cartel. Without information from documentary evidence, denunciations or leniency agreements, it becomes more difficult to construct the bidding matrix and to apply the screen.
- Another shortcoming of our economic screen is the possibility of finding the existence of a bid-rigging cartel when one does not truly exist (false positives). This can occur when bids are correlated due to the existence of unobserved variables that influence the placed bids.
- Therefore, our screen cannot be used as isolated and definitive proof of the existence of a bid-rigging scheme and it is necessary to collect additional documentary evidence.