

Beneath the Surface: Investigating Anti-Competitive Signals in Brazilian Public Procurement^{*}

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Abstract

This study employs a Regression Discontinuity design inspired by [Kawai et al. \(2023\)](#) to examine anti-competitive behaviors in 3.8 million public procurement auctions conducted in São Paulo, Brazil. By comparing narrowly winning and losing bids, we identify significant incumbency advantages and irregularities in bid timing. Our findings highlight that in developing countries, anti-competitive behaviors—even when unrelated to explicit corruption—can adversely affect the efficiency of public procurement systems.

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1. Introduction

Bid rigging in public procurement is a pervasive and costly problem that undermines competition and leads to artificially inflated prices, ultimately hurting taxpayers and diminishing the quality of public services (Porter and Zona, 1993; Pesendorfer, 2000). Across industries and countries, numerous cartels have been exposed—ranging from school milk contracts in the United States (Porter and Zona, 1993) to large-scale infrastructure projects in Europe and Latin America—which collectively demonstrate the persistent nature of collusive agreements over time. When firms conspire to prearrange who will win a given tender and at what price, the resulting lack of competition raises the costs of government projects, reduces incentives for innovation, and undermines public trust in the integrity of procurement processes. Beyond these immediate economic impacts, collusion can also deter honest businesses from entering the market, thus entrenching cartels and perpetuating a vicious cycle of reduced competition.

Despite stronger antitrust laws and growing sophistication in enforcement, detecting bid rigging remains a significant challenge because explicit collusion is often hidden behind layers of indirect signals and subtle coordination (Bajari and Ye, 2003). Conventional anti-cartel measures—such as investigating suspiciously high bids or relying on whistleblowers—can be reactive and incomplete, because colluding firms endeavor to hide obvious evidence of conspiracy. In the last two decades, researchers have increasingly turned to empirical indicators in auction data to unveil bid coordination. Early work by Porter and Zona (1993), for instance, revealed that some construction firms systematically submitted non-competitive bids in New York highway projects, demonstrating how inconsistent pricing patterns can flag collusive behavior. More recent studies apply advanced econometric techniques or big data analytics to procurement datasets, trying to isolate signals that are inconsistent with genuine competitive bidding (Conley and Decarolis, 2016; Imhof et al., 2018).

In this paper, we employ the methodology proposed by Kawai et al. (2023) and utilize a Regression Discontinuity design to identify patterns indicative of anti-competitive behavior in São Paulo’s public procurement data, covering 3.8 million contracts from 2009 to 2019. Our analysis specifically targets auctions decided by narrow margins to detect unusual incumbency advantages and strategic bid timing, which may suggest the presence of anti-competitive schemes among competing firms.

The intuition behind the method hinges on the fact that when two firms bid nearly

identical prices, the winner’s edge should be effectively random if all bidders are competing fairly. In other words, under true competition, there is no systematic reason for a narrowly winning firm to differ in characteristics, such as workload, cost structure, frequency of recent wins, from a narrowly losing firm. Hence, if we do observe abrupt differences in these attributes exactly at the point where bids are nearly tied, we can infer that external factors, possibly collusion or corrupt favoritism, are shaping the outcome. While other screening tools often rely on cross-auction patterns or price dispersion, this close-margin design zeroes in on the final, decisive cutoff where a contract is awarded.

In this paper, we apply the close-margin identification strategy to an extensive dataset of public procurement auctions in Brazil between 2009 and 2019. Brazil represents a particularly informative setting for studying collusion and favoritism due to its large-scale procurement programs, varied market structures, and well-documented concerns over corruption in certain sectors ([Organisation for Economic Co-operation and Development, 2015](#); [Bosio et al., 2022](#)). Over this period, electronic platforms became the norm for purchasing common goods and services, creating detailed digital records of bids and contract awards. These records enable us to trace whether the same group of firms repeatedly wins contracts by tiny margins or exhibits other patterns suggestive of non-competitive behavior.

Our empirical analysis provides strong evidence of significant discontinuities at the threshold of closely contested auctions, indicative of potential anti-competitive behaviors within public procurement markets. Specifically, we identify two distinct effects: first, firms narrowly winning auctions are approximately 1.8 percentage points more likely to be incumbents—firms that previously secured similar contracts—compared to narrowly losing bidders. This pattern suggests incumbents may gain disproportionate advantages, potentially through strategic bidding or coordinated behaviors. Second, narrowly winning firms demonstrate a substantially higher likelihood, around 6.4 percentage points, of submitting the auction’s final bid. This indicates possible strategic timing of bids, hinting at practices consistent with bid leakage or collusive behavior aimed at suppressing genuine competition. Importantly, these findings are robust after accounting for year and market fixed effects, strengthening the interpretation that observed discontinuities are reflective of deliberate, anti-competitive strategies rather than random occurrences.

The structure of the paper is as follows. Section 3 provides an overview of Brazil’s institutional background, describing how public procurement operates under a decentralized yet increasingly digitized framework. Section 5 describes the dataset and explains

our construction of key variables, including the precise definition of the margin between winner and runner-up bids. We then lay out the RDD methodology in Section 4, detailing how we isolate borderline auctions and measure any discontinuities in firm attributes around the winning threshold. Section 6 presents our main empirical results, showing stark evidence of rotation-type collusion. Section 7 explores additional analyses and robustness checks, such as splitting the sample by contract size and testing for local manipulation of the margin. Finally, Section 8 offers concluding remarks on the policy implications of our findings and potential directions for future research on collusion detection in procurement auctions.

2. Literature Review

Collusion in public procurement auctions has been extensively studied through the lenses of game theory, empirical analysis, and policy evaluation. A rich theoretical literature explains how bidders can sustain collusive agreements in repeated auction environments. Key mechanisms include bid rotation, where cartel members take turns winning contracts, and strategies to deter outsider entry. For example, dynamic models show that bidding rings can allocate wins intertemporally without side payments by rotating bids in a predetermined order, ensuring that each cartel member secures a share of contracts over time. Auction format and information flow also matter: tacit coordination can emerge even without explicit communication, especially under auction designs that facilitate monitoring of rivals' behavior. Notably, uniform-price auctions tend to relax competitive pressure more than pay-as-bid formats, thereby facilitating implicit collusion ([Porter and Zona, 1993](#)).

Empirical evidence since the 2000s demonstrates that collusive schemes are not merely theoretical constructs but real phenomena observed across different regions. Numerous documented cartels in procurement markets illustrate various collusive strategies. In Japan, for instance, construction contractors have systematically rigged bids on public works projects, with nationwide tender data revealing widespread coordination ([Kawai et al., 2023](#)). Within such schemes, firms often allocate subsequent contracts to the member that has gone the longest without winning, a clear indicator of bid rotation. Similar patterns have been identified in Italy, Scandinavian countries, and in Brazil's public contracting, where studies document that collusive rings inflate contract prices and coordinate bidding behavior through predictable bid rotations and artificially close bids

([Bajari and Ye, 2003](#)). These patterns persist over time, leading to higher procurement costs and diminished competition ([Conley and Decarolis, 2016](#)).

Given the covert nature of collusion, researchers have focused on developing robust detection methods. Traditional econometric approaches leverage the insight that collusion distorts the statistical properties of bids. For example, tests have been developed to assess whether bidders' cost estimates or bid rankings are exchangeable under competitive conditions, with systematic deviations serving as red flags for collusion ([Bajari and Ye, 2003](#)). More recent work has advanced these methods by applying Regression Discontinuity (RD) designs that exploit near-tie auctions, where the winning margin is nearly zero. Under true competition, firms in such close contests should display similar characteristics, and any systematic differences can indicate collusive coordination ([Imhof et al., 2018](#)). These techniques have successfully detected collusion in various procurement settings, highlighting that even sophisticated cartels leave measurable traces in bidding behavior.

Policy responses to collusion have evolved significantly since 2000. Regulatory frameworks now emphasize proactive detection and robust enforcement. Leniency programs, which incentivize cartel members to self-report by offering reduced penalties, have been widely implemented and have been shown to destabilize collusive arrangements ([Organisation for Economic Co-operation and Development, 2015](#)). In parallel, governments have refined auction design—by increasing transparency, enforcing strict bid submission protocols, and adopting electronic procurement platforms—to reduce the opportunities for bid rigging. Empirical studies indicate that such measures, when effectively enforced, lead to lower procurement costs and more competitive outcomes ([Bosio et al., 2022](#)).

Looking ahead, recent innovations in machine learning and network analysis are poised to further enhance collusion detection. These advanced methods can process vast quantities of bidding data to identify subtle patterns that traditional econometric screens may overlook, offering a more comprehensive toolkit for uncovering collusive behavior. As digital procurement continues to expand globally, integrating these tools into routine oversight could significantly improve market competitiveness and safeguard public resources.

In sum, the post-2000 literature paints a comprehensive picture of collusion in procurement: it is grounded in robust theoretical frameworks, confirmed by empirical evidence across diverse jurisdictions, and addressed by increasingly sophisticated detection and regulatory strategies. This body of work not only deepens our understanding of col-

lusive behavior but also provides practical guidance for interventions aimed at preserving competitive procurement markets.

3. Institutional background

Public procurement in the state of São Paulo is conducted through a decentralized system of purchasing agencies, each referred to as a Public Buyer Unit (PBU). Since 2007, the use of the state’s electronic procurement platform, the *Bolsa Eletrônica de Compras* (BEC), has been mandatory for PBUs when acquiring common goods and services. The BEC platform centralizes tender procedures and records detailed information on each procurement process. It plays a crucial role in São Paulo’s procurement operations: for instance, in 2018 alone, approximately US\$1.7 billion worth of goods and services were procured via BEC. Over the period from 2009 onward, the BEC system handled more than R\$7.4 billion (approximately 34% of all state government purchases) for the State Health Secretariat (SES/SP) and other agencies in São Paulo. Given the large scale and value of these tenders, ensuring fairness and preventing collusion in the procurement process is of paramount importance. A failed tender (one that ends with no supplier selected) not only delays public service delivery but also wastes significant administrative resources, as each tender process can cost the government between US\$500 and US\$5,200 in preparation and execution.

The BEC catalog contains a comprehensive listing of standardized items and services, classified by category. Nearly 55,000 purchase offers were issued through BEC during our study period, covering about 6,350 distinct items ranging from medical supplies to office equipment. Each purchase offer (PO) is a digital solicitation document that identifies one or more items to be procured, along with the required quantities and specifications. Each item within a PO is auctioned separately; thus a unique procurement transaction can be defined by a combination of a PO number and an item code (POI). The BEC records include rich information for each POI, including the reference (reserve) price set by the buyer, the number of participating firms, all bids submitted (identifying winners and losers), the auction format used, and the identities of the buyer (PBU) and auctioneer.

São Paulo’s PBUs predominantly use two types of competitive tendering procedures available on BEC: (i) a sealed-bid tender (*convite*) and (ii) a multi-round descending auction (*pregão*). In a sealed-bid tender, firms submit confidential bids by a specified deadline. After the submission period closes, all bids are opened and the contract is

awarded to the qualified bidder with the lowest bid price. The sealed-bid format is typically used for purchases up to a value limit of R\$176,000 (approximately US\$35,000). In contrast, the descending auction (pregão) has no value limit and involves an open, interactive bidding phase. Initially, firms submit sealed proposals which are evaluated for qualification. Then, all qualified bids are announced (with the bidders' identities concealed) and an open auction phase commences. During this phase, which lasts for an initial 20 minutes, bidders can submit progressively lower bids, knowing the current lowest bid in real time. If a new bid is placed in the final minutes of this period (between 16 and 20 minutes), the auction is automatically extended by an additional 4 minutes. The auction concludes when no new bids arrive for 4 consecutive minutes. The winner is the bidder offering the lowest price at the end of this process, provided that price is below the government's preset reference price.

The key difference between the sealed-bid and descending auction formats lies in the opportunity for iterative bidding and post-auction negotiation. The pregão format, after determining the lowest bid through the auction, often allows a brief negotiation or confirmation step to potentially further reduce the price or clarify terms with the lowest bidder, as permitted by Brazilian procurement rules. In contrast, the convite (sealed bid) format is a single-shot process with no negotiation stage, which makes it simpler but also means the outcome is entirely determined at bid opening. From an oversight perspective, the open auction format provides more transparency during the bidding process (as all bids are observable in real time, albeit anonymously), whereas the sealed bid format concentrates all transparency at the moment of opening. Both mechanisms are subject to anti-collusion regulations and audit processes, but their procedural differences can influence how collusion or favoritism might manifest. Our analysis will focus specifically on sealed bid auctions.

4. Identifying anti-competitive behaviors

Our empirical strategy follows the approach of [Kawai et al. \(2023\)](#) to detect subtle signs of collusion or favoritism in auction outcomes. The core idea is to focus on procurement auctions where the competition is extremely tight, meaning the winner's bid is nearly identical to the runner-up's bid. Under genuinely competitive conditions, two firms bidding almost the same price should be similar in their cost efficiency and should not systematically differ in their past bidding success. Thus, absent any collusion or

external favoritism, one would expect no abrupt differences in firm characteristics when moving from just losing an auction to just winning it.

We implement this idea using a regression discontinuity design (RDD) centered around the margin of victory. Let $\Delta_{i,t}$ be the difference between firm i 's bid and the lowest competing bid in auction t . This margin $\Delta_{i,t}$ serves as our running variable, with a cutoff at zero. Firms with $\Delta_{i,t} < 0$ win the auction (their bid is lower than the best alternative), whereas those with $\Delta_{i,t} > 0$ lose. Intuitively, $\Delta_{i,t} = 0$ represents a threshold between winning and losing. We focus on auctions where $|\Delta_{i,t}|$ is very small, meaning the winner barely underbid the closest rival. In such cases, any systematic jump in firm outcomes at $\Delta_{i,t} = 0$ can be interpreted as evidence of an outside influence on the auction result.

The two primary outcomes we examine are the firm's *incumbency status* and its bid timing, identifying whether it is the *last bidder* in the auction. We define an *incumbent* as a firm that won the last auction it participated in prior to the current auction (incumbency is an indicator variable equal to 1 if the firm was the previous winner and 0 otherwise). *Last bidder* identifies whether a firm was the last among the competitors to submit the bid. By examining these variables for firms just on either side of the winning threshold, we can detect irregular patterns: for instance, an unexpectedly high incumbency rate or unusually larger probability of being the last bidder for firms that barely win compared to those that barely lose.

Formally, we estimate the discontinuity at $\Delta = 0$ for these outcomes. Let $x_{i,t}$ denote a generic outcome (such as the incumbency indicator or backlog) for firm i before auction t . The discontinuity is captured by the difference in the expected value of $x_{i,t}$ immediately to the left and right of the cutoff:

$$\beta = \lim_{\epsilon \rightarrow 0^+} \mathbb{E}[x_{i,t} \mid \Delta_{i,t} = \epsilon] - \lim_{\epsilon \rightarrow 0^-} \mathbb{E}[x_{i,t} \mid \Delta_{i,t} = \epsilon] ,$$

where ϵ is a small positive increment in the bid margin. In the absence of any strategic behavior or external interference, we would expect $\beta \approx 0$ for characteristics like incumbency, since firms just winning or just losing should be comparable. Conversely, a significant $\beta \neq 0$ indicates a discontinuous jump in firm characteristics at the threshold, consistent with non-competitive forces affecting the outcome.

We hypothesize that a positive advantage conferred to narrowly winning firms would manifest as $\beta > 0$ in our setup (because the outcome for winners exceeds that for losers).

Detecting a substantial gap in these measures at $\Delta = 0$ will allow us to distinguish between a competitive market and one influenced by collusion or favoritism.

For example, if there is political favoritism benefiting certain firms, those firms would appear as incumbents much more often when they win narrowly, whereas otherwise identical firms that narrowly lose would not show such a history. Similarly, a collusive bid-rotation scheme might lead to a more equal distribution of recent wins among participants, in which case we would *not* expect a sharp drop in backlog for losing firms at the threshold.

5. Data

5.1. Sources

We utilize a rich administrative dataset of public procurement auctions conducted via the BEC platform in São Paulo state. The dataset covers the period from January 2009 to December 2019 and includes detailed bid-level information for auctions of common goods and services. During this period, 1,344 PBUs (encompassing state-level executive agencies, the legislative and judicial branches, as well as some municipal governments and even a few private organizations authorized to use the system) carried out procurement through BEC. In total, the data comprise 3,866,407 individual bidding transactions submitted by 19,007 distinct firms, corresponding to 169,607 unique procurement items. Each record in the data identifies the purchase offer (PO) and item, the participating firm, the bid amount, and the auction outcome (win or loss), among other details.

The BEC system’s hierarchical catalog organizes items into groups and classes. For example, medical supplies are grouped under a specific category (e.g., group 65 for medical and hospital items), with finer classifications down to individual item codes.¹ This structured coding is useful for analyzing procurement patterns by item type or sector. Our analysis leverages the full breadth of goods and services in the dataset, while controlling for any category-specific effects as needed.

For the purposes of our study, we focus on competitive tenders that resulted in a contract award (i.e., at least one winner and one or more losing bids). We exclude tenders that were canceled or received only a single bid, since those do not provide information on

¹An illustrative item is code 110639, which corresponds to "Furosemide 40mg tablets," classified under class 6531 (a category of pharmaceuticals) within group 65.

competitive dynamics. This yields a sample of auctions where a meaningful competition took place, which is essential for implementing our regression discontinuity approach.

5.2. Variable definitions

We construct key variables to capture firm outcomes and auction characteristics. First, we define a market such that two firms belong to the same market if they participated at least once in the same auction for the same type of good. This market classification is transitive, resulting in 7,581 distinct markets defined within at least one of our defined time periods.

Following [Kawai et al. \(2022\)](#), we construct an *Incumbent* dummy variable based on this market definition. Specifically, this variable equals 1 if a given firm won the last auction it participated in within the same market before the current auction, and 0 otherwise. This indicator reflects whether the firm entered the current tender as a reigning winner (incumbent) in the specific market or not.

Additionally, we define the *Last Bid* dummy variable equal to 1 if the firm was the last to submit a bid in the auction, and 0 otherwise.

Finally, we define the *Margin of Victory*, which serves as the running variable in our RDD design. For each auction, the margin of victory is calculated as the percentage difference between the winning bid and the second-lowest bid, expressed as a fraction of the winning bid. Formally, if b_{win} is the winning bid and $b_{\text{runner-up}}$ is the next lowest bid, the margin is $(b_{\text{runner-up}} - b_{\text{win}})/b_{\text{win}}$. When this margin is very small, the auction outcome was decided by a tiny price difference.

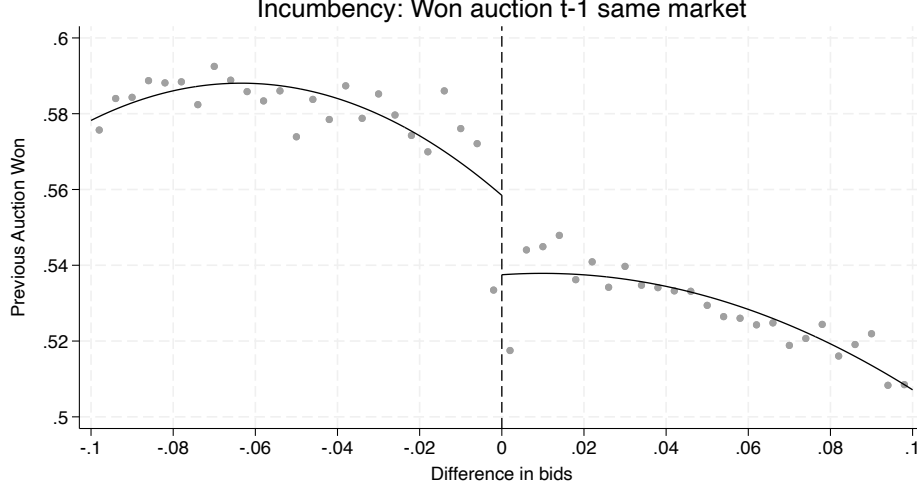
6. Empirical Results

Our empirical analysis identifies statistically significant discontinuities at the threshold of closely contested auctions, suggesting potential anti-competitive dynamics in public procurement markets.

Graphical representations of these effects are illustrated in Figures 1 and 2. Quantitative estimates supporting the graphical evidence are presented in Table 1. Figure 1 shows the estimated probability that the winning firm was the incumbent—defined as the firm winning the immediately preceding auction for a similar good—as a function of the bid margin. A clear discontinuity at the threshold (bid margin equal to zero) indicates that firms narrowly winning auctions (negative bid margin) exhibit a higher

probability of incumbency compared to narrowly losing firms (positive bid margin). This pattern is consistent with incumbent firms benefiting disproportionately, which may be reflective of strategic bidding practices or bid rotation schemes.

Figure 1: Probability of Incumbency around the Bid Margin

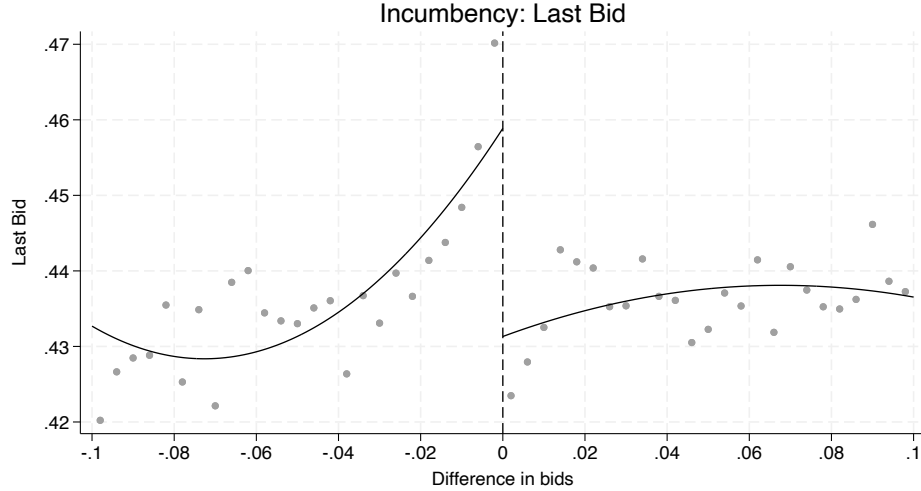


Notes: The figure plots binned averages of incumbency status against the bid margin, where negative values correspond to narrowly won auctions and positive values reflect narrowly lost auctions. A distinct discontinuity at the cutoff suggests potential incumbency advantages.

Similarly, Figure 2 examines the probability that the winning firm submitted the last bid in the auction as a function of the bid margin. A comparable discontinuity at the cutoff suggests firms narrowly winning auctions have a higher likelihood of being the final bidder, potentially indicating strategic bid timing indicative of anti-competitive behavior, such as bid leakage or collusion.

The regression discontinuity estimates corresponding to these graphical results, accounting also for year and market fixed effects, are reported in Table 1. We find that being the incumbent is associated with a 1.82% increase in the probability of winning an auction within the same market. Similarly, winning firms are 6.36% more likely to submit the final bid. Both coefficients are statistically significant at the 1% level. The results remain robust to the inclusion of market and year fixed effects and statistically support the graphical evidence, reinforcing the interpretation of non-competitive forces at play in closely contested procurement auctions.

Figure 2: Probability of Being the Last Bidder around the Bid Margin



Notes: The figure plots binned averages of the probability that the winning firm submitted the last bid against the bid margin, where negative values correspond to narrowly won auctions and positive values reflect narrowly lost auctions. A discontinuity at the threshold indicates potential strategic timing in bid submissions.

Table 1: Effect of Winning Auction on Key Outcomes

	Incumbent		Last Bid	
	(1)	(2)	(3)	(4)
Winning Auction	0.0182*** (0.005)	0.0179*** (0.005)	0.0636*** (0.008)	0.0636*** (0.008)
Observations	261370	260985	156418	156418
Optimal Bandwidth	0.02	0.02	0.01	0.01
Year FE		✓		✓
Market FE		✓		✓

Notes: Standard errors are reported in parentheses. *** indicates statistical significance at the 1% level. The dependent variables are defined as follows: (1) *Incumbent* is a dummy indicating whether the firm won the previous auction within the same market; (2) *Last Bid* is a dummy variable indicating whether the winning firm submitted the final bid in the auction.

7. Additional Results - TBC

7.1. Heterogeneity by market

7.2. Correlation with predicted corruption

7.3. Firms outcomes

8. Conclusion

This paper tests a novel approach to detecting anti-competitive behavior in public procurement, applying it to auction data from São Paulo, Brazil. Inspired by [Kawai et al. \(2023\)](#), we use a regression discontinuity design around narrowly decided sealed-bid auctions to identify significant incumbency advantages and strategic bidding behavior. Specifically, narrowly winning firms are more likely to have won prior auctions and to submit the final bid, indicating favoritism or collusion inconsistent with purely competitive bidding.

These findings highlight vulnerabilities in the Brazilian procurement systems, suggesting that both corruption and firm collusion may distort competition. Finally, our analysis provides a practical tool for procurement oversight bodies to flag potential anti-competitive practices and improve accountability in public contracting.

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A. Appendix