Kamikazes in Public Procurements: Bid-Rigging and Real Non-Market Outcomes *

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Abstract

Bid-rigging in public procurements has severe implications for public service quality. We document a prevalent coordination strategy in Brazil, where the lowest bidder withdraws post-auction, allowing the second-lowest bidder to win at higher prices. This "kamikaze" strategy occurs in 17% of auctions, increasing prices by up to 11.7%. Evidence of coordination comes from ownership ties, common addresses, and repeated partnerships between kamikaze and winning firms. Coordination declined following a transparency reform that made ownership connections visible to auctioneers. Ultimately, such coordination correlates with adverse real non-price outcomes: increased road accidents following maintenance contracts and higher mortality rates in public hospitals.

Keywords: public procurement, bid-rigging, shared ownership, non-market outcomes, road safety, hospital mortality
JEL Classification: G34, G38, H41, H57, L22, L41

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Governments spend significant resources purchasing goods and services from private companies, with public procurements constituting 12% of the global GDP (Bosio et al., 2022). Given this economic significance, inefficiencies in the procurement process can have severe consequences, including on the quality of public service provision (Transparency International, 2015). One key source of such distortions is bid-rigging — when private firms collude to extract rents from the government — which can increase public costs by up to 20% (OECD, 2009). Beyond higher prices, bid-rigging may also distort which firms win contracts, potentially awarding contracts to less efficient firms that may deliver lower-quality services. This paper examines how bid-rigging can lead to inefficiencies that ultimately harm public service provision.

Quantifying these negative externalities of bid-rigging is challenging for at least two key reasons. First, explicit coordination is usually only observable in prosecuted cases, which likely represent a small and potentially biased sample (Chassang et al., 2022; Kawai and Nakabayashi, 2022). Second, identifying the link between bidding practices and service quality requires comprehensive data on both procurement auctions and public services. We overcome these challenges by leveraging a novel dataset of Brazilian public procurements that contains the complete bidding process for 15 million distinct item purchases between 2005 and 2021. Government institutions conduct these purchases via first-price electronic reverse auctions, where bidders compete in real time by offering successively lower prices. Using this rich dataset, we identify a specific and prevalent pattern suggestive of bid-rigging: in 17% of the auctions, the lowest bidder ("kamikaze") withdraws post-auction, allowing the second-lowest bidder to win.[1] We then study how this behavior affects the quality of essential public services in two contexts: road accidents and hospital mortality rates.

We first provide descriptive evidence on whether these withdrawals represent strategic coordination or honest mistakes. The evidence is difficult to reconcile with honest mistakes alone and points toward coordination. Compared to other participants in the same auction, firms are more likely to win when they share owners (7.8 p.p. higher) or addresses (6.8 p.p. higher) with the kamikaze firm, or when they previously won auctions where this same firm acted as kamikaze (18.7 p.p. higher). Moreover, kamikaze firms are smaller and younger than winners and frequently act as kamikazes across multiple auctions, suggesting they serve as special-purpose entities that facilitate collusive bidding strategies.

Connected firms could, however, win more often for reasons other than coordination. To investigate this, we employ a regression discontinuity design that relies on plausibly

[1] Similar practices have also been observed in the U.S. as the Department of Justice (2021) mentions that *"in some schemes, a low bidder will agree to withdraw its bid in favor of the next low bidder in exchange for a lucrative subcontract that divides the illegally obtained higher price between them."*

exogenous variation in which firms benefit from kamikaze withdrawals. We focus on auctions where the same kamikaze firm submits the lowest bid but connected and unconnected rivals have nearly identical bids for second place. Because Brazil's reverse auctions close at a randomized time, which firm ends just ahead in these near-ties is effectively random (Ferraz et al., 2021). Thus, when second-place and third-place bids are nearly identical, kamikaze firms cannot predict during the auction whether their connected partner will finish in second place. They can only observe the ranking of bids and associated firms after the auction ends. Unless they coordinate, the withdrawal decision should not be linked to the identity of the second-place bidder. Yet, we find that they are significantly more likely to withdraw when connected firms narrowly secure this position, providing evidence of information sharing and deliberate coordination rather than independent correction of bidding mistakes.

As a second piece of plausibly exogenous evidence of coordination, which also addresses the endogeneity in where and when kamikaze behavior arises, we investigate a 2014 transparency reform that allowed auctioneers to observe shared ownership between bidders. This change raised the risk of detection for kamikaze and winning firms connected through shared ownership, making their coordination costlier. If shared ownership were not used to coordinate, the reform should not have changed these firms' behavior. Instead, a difference-in-differences design shows the opposite. Among firms that had won kamikaze auctions while sharing ownership with a kamikaze firm, both their participation in and their winning of auctions involving shared ownership declined after the reform. Supporting our identification strategy, the probability of participating in such an auction shows no differential pre-trend before 2014 and declines only afterwards. Combined with the ownership and address connections and the repeated pairings, these findings on random auction ending times and the transparency reform provide evidence of deliberate coordination.

We further document that this coordination translates into higher prices. Procurement prices are 9.3-11.7% higher in kamikaze auctions, i.e., when the lowest bidder quits and the second-lowest bidder wins, compared to similar auctions without such withdrawals, and indeed the overpricing is largest when kamikaze and winning firms share connections. Such effects are consistent when controlling for high-dimensional fixed effects and controls, i.e., the same institution purchasing the same item in the same year, the auction having the same number of participants, the same number of past auction winners, and similar participant characteristics. Consistent with coordination, prices fell after the 2014 transparency reform precisely in auctions involving firms that, before the reform, had most relied on shared-ownership coordination with kamikaze firms.

We next turn to where this overpricing comes from. One possibility is that kamikaze bidding deters more efficient bidders from active competition and results in a different ranking of bidders than would otherwise occur. The second possibility is that the ranking does not change but the most efficient bidder is able to extract higher rents. We decompose these two effects by controlling for winner fixed effects, i.e., by comparing the same firm across its own kamikaze and non-kamikaze wins. Indeed, most of the effect comes from the bidder ranking, i.e., less efficient firms winning, as after controlling for winner fixed effects, the effect falls from 9.3% to about 3%. The remaining overpricing reflects weaker competition even for the same winner. This is in fact evident from bidding behavior in kamikaze auctions: non-kamikaze firms submit 0.9 to 1.1 fewer bids per bidder than in similar auctions without kamikazes, and their bids are 3-5% less dispersed.

These empirical findings are consistent with a theoretical framework we develop that highlights how kamikaze strategy can systematically increase prices. The key insight is that kamikaze bids create uncertainty: when genuine bidders observe extremely low kamikaze bids, they cannot distinguish real competition from bids intended to be withdrawn. Combined with fixed bidding costs, such as investing resources to participate in the auction, this uncertainty deters competitive bidding behavior. Some competitors exit the auction entirely, believing they cannot compete with such low bids. Others remain, but bid less aggressively, anticipating reduced overall competition. The framework predicts that this deterrence is most effective when coordinating less efficient bidders possess superior information about withdrawals, knowing with certainty which bids will disappear.

Having established that kamikaze behavior has patterns consistent with strategic coordination and is associated with overpricing, we use this behavior as a marker to examine how the resulting inefficiencies affect public service provision. Looking across all procurement contracts, we find that winners in kamikaze auctions deliver worse contract performance (higher cancellation rates, more cost overruns, and longer delivery times) indicating that coordination selects lower-quality providers. These effects are amplified when kamikaze and winner firms are connected through shared owners, addresses, or repeated relationships.

We zoom into providing more granular evidence on the negative externalities by focusing on two specific contexts. First, we investigate how kamikaze bidding is associated with lower road quality and an increased number of road accidents. Roads maintained under kamikaze auction contracts require additional maintenance approximately one year earlier than comparable roads repaired through non-kamikaze auctions, indicating inferior repair quality and accelerated deterioration. Moreover, roads awarded in kamikaze auctions experience 13.7% more accidents due to poor road conditions and 9.6% more victims from such accidents. These effects are consistent after controlling for project complexity. Instead, we find no impact on accidents that are not related to road quality (e.g., speeding, drunk or distracted driving). This suggests a channel through which bid-rigging in public procurements can affect real outcomes: the selection of less efficient suppliers, which compromises both infrastructure durability and public safety.

Second, we find that kamikaze bidding may affect hospital mortality rates through the purchase of essential medicines. Using data on 61 federal hospitals in Brazil, we compare mortality rates between hospitals that acquire medicines for the same disease in the same quarter but differ in their exposure to kamikaze bidding in these procurements. Kamikaze auctions for essential medicines are associated with a 19% increase in hospital mortality rates in subsequent years, relative to the unconditional average. These effects persist even when comparing health outcomes within the same hospital in the same year, which controls for any time-varying differences in hospital quality, management, or other characteristics that might affect mortality rates. As essential medicines have precise specifications and do not differ in quality, this effect is likely explained by disrupted supply of specific drugs: colluding winners deliver later or fail to deliver altogether, compromising treatment for the conditions those medicines address. Falsification tests using non-essential procurement and "wrong" disease assignments confirm that the effect is drug-disease-specific rather than hospital-wide. In both road maintenance and hospital cases, the negative effects are significantly stronger when the kamikaze and winning firms are connected, suggesting that the capacity to coordinate is positively associated with poorer service quality.

Our evidence implies that overpricing in government auctions could result in serious negative real effects beyond those on consumer welfare, labor or financial markets, i.e., it could also have strong non-market effects, e.g., on health and public services. These findings also bring attention to one particular coordination strategy — kamikazes — that is associated with significant overpricing. They also support Kumar et al. (2015), who suggest that one reason why firms exist is to give the impression of competition in public procurements. While this paper uses ex-post observable kamikaze strategy to proxy for bid-rigging behavior, the fundamental mechanisms — reduced competition through coordination or deterrence, leading to higher prices and less efficient providers — are likely to remain the same across different procurement formats and bid-rigging strategies, such as bid rotation, market division, and complementary bidding.

Our paper contributes to the literature on cartel detection (e.g., Porter and Zona, 1993, 1999; Bajari and Ye, 2003; Chassang et al., 2022; Houde et al., 2022; Kawai et al., 2023) by documenting bid-rigging behavior and showing how it is linked to negative real effects in public service provision. More generally, the literature has extensively documented different types of bid-rigging behavior as well as methods of detecting it (e.g., Porter, 2005; Whinston, 2008; Asker, 2010; Marshall and Marx, 2012; Andreyanov et al., 2018; Baránek et al., 2021). Instead, we use a bidding strategy consistent with coordination in order to study non-market outcomes, such as hospital mortality rates and road safety conditions, and to quantify the broader real outcomes resulting from firm coordination in procurement auctions. In doing so, we also contribute to studies on the broader macroeconomic implications and other externalities resulting from public procurement auctions such as employment (Goldman, 2020), firm growth (Ferraz et al., 2021), entry (Brogaard et al., 2026), entrepreneurship (Pecenco et al., 2024), productivity (di Giovanni et al., 2024), procurement discretion and quality (Fazio, 2026), healthcare access (Barkley, 2023), and infrastructure (Liscow et al., 2023). Our analysis also reveals *how* bid-rigging patterns harm public services by facilitating the selection of suboptimal contractors. These findings expose the risks of low competition in public procurements beyond immediate fiscal implications.

We also relate to the public procurement literature that has examined cases where abnormally low bids win the contract but later default or seek renegotiation due to cost miscalculations or financial distress (e.g., Spulber, 1990; Zheng, 2001; Decarolis, 2014).[2] However, unlike these scenarios where low bids are followed by renegotiations, kamikaze firms submit low bids but strategically withdraw before signing the contract, allowing the second-lowest bidder to win at a higher price. This is likely a deliberate form of coordination rather than cost misestimation, highlighting a more covert form of bid-rigging that drives up prices, imposing hidden costs on public budgets and limiting financial resources for public services.

Finally, as we observe that the coordination is prevalent in cases where the winning firm and the kamikaze share ultimate owners, we relate to the finding in Charoenwong and Asai (2020) who show that shared ownership networks are positively associated with higher contract prices in public procurement auctions.[3] In addition to these coordination mechanisms and related to the broader corporate ownership implications, we provide new evidence of how firm ownership can affect patient health outcomes (e.g., Azar et al., 2018; Eliason et al., 2019; Ashtari Tafti and Hoe, 2022; Liu, 2022; Schmalz and Xie, 2022; Gupta et al., 2024) and have other externalities such as reduced road quality. More broadly, firms actively design institutional arrangements to enable coordination, whether through ownership structures as we document here, through executive compensation that rewards collusion when enforcement weakens (Ha et al., 2024), or through political ties that reduce oversight and facilitate preferential treatment (Faccio et al., 2006; Duchin and Sosyura, 2012; Schoenherr, 2019).

[2]For example, the European Commission (2002) mentions that *"contractors who intentionally submit abnormal tenders might be those who seek an ex-post renegotiation (...) (or those) in bad financial conditions (...) in search of a contract in order to obtain a cash advance from their client or bank."*

[3]See Schmalz (2021) for a recent literature review on common ownership and industrial organization.

1 Data

Our main dataset comes from ComprasNet, the electronic platform where government institutions conduct procurements. As such, it contains information on the universe of federal public procurements in Brazil, including procurement outcomes, descriptions of the items (goods or services) purchased, a list of participants, and their bidding history from September 2005 to August 2021.[4] The data covers 4.8 thousand government institutions purchasing 139 thousand distinct items and services in 15 million auctions. The average auction in the data had seven participants, each making 4.7 bids, totaling about 450 million distinct bids.[5]

To ensure accurate categorization of goods and services, we match items with their official government registry, namely the *Cadastro dos Materiais* (CADMAT) for products and the *Cadastro dos Serviços* (CADSER) for services. Panel A of Internet Appendix Table A1 provides an example list with selected products and services, while Panel B presents a selected list of government institutions present in the database.

Our analysis of the real non-market outcomes relies on several secondary sources. We use the Transparency Portal (*Portal da Transparência*) to assess the quality of public contracts through budget execution data. Hospital mortality data in the Brazilian Unified Health System (*Sistema Unificado de Saúde - SUS*) is obtained from DataSUS. Information on accidents and victims on Brazilian roads comes from the Federal Highway Patrol (*Polícia Rodoviária Federal*). Lastly, we gather firms' locations, industry, size category, and ownership structures from the Brazilian Federal Revenue Service (*Receita Federal*).

Table 1 presents the summary statistics for the main variables used in our analysis. Across the entire sample period, 17% of the auctions had at least one kamikaze firm, and the average number of kamikaze firms per auction was 0.36.

2 Institutional Background

Brazil primarily conducts procurements for standardized goods and services via competitive bidding (*Pregão Eletrônico*), where the government awards public contracts to the lowest bidder in first-price electronic reverse auctions. Bidders compete in real time by offering successively lower prices for their goods and services, with the lowest price winning the contract. Such electronic reverse auctions are a common procurement practice worldwide: according to the World Bank's Global Procurement Database, 50 out of 152 surveyed coun-

[4]Local governments can also use ComprasNet for at least a part of their purchases. In the total sample, these local governments add up to 9% of the transactions.

[5]Internet Appendix Figures A1 and A2 show the geographical distribution of institutions and bidders.

tries employ similar systems, including the U.S., the United Kingdom, France, Russia (Best et al., 2023), Israel, India (Lewis-Faupel et al., 2016), and Mexico. In contrast, countries like Germany, Italy, Canada, South Korea, and Singapore tend to use first-price sealed bid auctions. These electronic auctions can generate substantial savings: U.S. federal agencies reported 12-14% cost reductions (United States GAO, 2013).

In Brazil, the process begins with regulatory approval, followed by the issuance of a detailed notice explaining the objective of the purchase (e.g., acquisition of painting materials), the item(s) demanded (e.g., paint sealer, acrylic paint), and clarifying the other proceedings of the auction. Typically, the items in a single procurement notice share a common objective, but each item usually constitutes its own separate auction. The procuring institution then collects proposals from potential bidders, doing so until the date of the electronic bidding. These institutions then evaluate the proposals and approved bidders are authorized to participate in the electronic bidding stage, which takes place in the ComprasNet portal.

Bidders' initial proposals to the procuring institution automatically become their first bids. Once the bidding stage starts, participants can submit another bid, which must be lower than their previous bid but can be larger than the lowest overall bid at that moment. In real time, bidders observe their own bid and the overall lowest bid but not the history of the bids, nor the identities of other bidders.[6] Meanwhile, the auctioneer observes the identities of all bidders and has the right to remove suspicious bidders from the auction. Since 2014, the auctioneer also has access to the ultimate ownership structures of the auction participants.

Brazilian procurement auctions end at a quasi-randomized time (Ferraz et al., 2021): the auctioneer has discretion to announce the end of the auction, after which the system randomizes the actual auction end within the next 30 minutes. After the bidding ends, the auctioneer declares the lowest bidder the winner, who must then submit documents that prove the firm's going concern status. If approved, both parties sign the public contract. However, if the winner fails to meet requirements — whether by withdrawing, not submitting the required documents, or providing inadequate documentation — they are disqualified, and the second-lowest bidder becomes the new winner. This process continues until the contract is signed and the procurement ends.

In this paper, we study cases when original winners fail to sign the public contract and do so *within hours or days*[7] after the end of the auction. While this may result from honest mistakes or cost misestimations, e.g., as a result of a "winner's curse" realization, we analyze whether such behavior can be attributed to strategic coordination and whether that has any real non-market outcomes. In fact, Brazilian regulators have expressed suspicions that

[6] Internet Appendix Figure A3 provides a screenshot of ComprasNet from the bidder's perspective.

[7] The median between the end of auction and withdrawal is 5 days.

this behavior may be part of a bid-rigging process,[8] and these bidders have been coined "kamikazes",[9] not least since they tend to have bids that are much lower than the second-lowest bid. We define potential winners that fail to sign the public contract as *kamikaze firms* and auctions that have at least one such kamikaze firm as *kamikaze auctions*.

Using data from ComprasNet, we find that such a pattern is relatively common. In Figure 1, we plot the fraction of kamikaze auctions in Brazil semiannually between 2007 and 2021. We see that, on average, 17% of procurement auctions in Brazil can be considered as having a kamikaze firm.

Figure 2 illustrates the bid dynamics for the final 45 minutes of the auctions. We plot the median bids for three types of bidders: the kamikaze bids (blue, circle) whose bids are eventually forfeited; the winners (red, square), defined as the lowest non-kamikaze bid; and "runner-up" bidders (orange, triangle), the next lowest in non-forfeited bids. All bid prices are normalized by the winning bid. To construct this plot, we gather bids for each auction at one-minute intervals, carrying forward the last bid if they do not update it within a minute. We then calculate the median across all bids in the sample for each bidder type and plot the findings. Three key patterns emerge. First, kamikaze bids are 15% lower than winning bids in the same auctions, which is an order of magnitude larger than the difference between lowest and second-lowest bids in non-kamikaze auctions, calculated to be 1% as shown in Internet Appendix Figure A4. Second, winners stop reducing the bid around 12 minutes before the end of the auction, which could reflect superior information about the kamikaze's withdrawal. Third, kamikaze firms continue to reduce the bids until the end of the auction, potentially deterring competition by non-kamikaze firms. In addition to Figure 2, which plots a single median series per bidder type, we plot two particular auctions separately. Figure 3 shows that in these auctions kamikazes cut their bids until the auction close while genuine bidders stop competing earlier, leaving the winner and runner-up nearly tied at the end of the auction.

Despite the availability of potential solutions, such as the requirement to submit the documents for prequalification before the auction, the posting of a monetary commitment such as a surety bond, or the imposition of fines, the enforcement against kamikaze behavior in Brazil is limited. Federal Law No. 10,520/2002 allows for banning offenders from participating in public procurements for a maximum of five years. Such punishments are rarely given, weakening their deterrence effect. According to the Open Data on Public Purchases Portal,

[8] *Tribunal de Contas da União* (TCU)'s Acordao no. 1793/2011: *"it is possible that there are companies reducing prices (...) to discourage the participation of other bidders (...) later withdrawing from the bidding to benefit another company (...) participating in the collusion, which (...) ends up being hired without having presented the best proposal, thus causing damage to the Administration."*

[9] They have also been called "divers" or "rabbits".

during our sample period, 83 thousand firms were disqualified after winning the auction, but only 13 thousand, or 15%, received legal action against this behavior. When penalized, these firms are banned from participating in federal public procurement by a median of 180 days, which is significantly less than the maximum of five years allowed by the law.

Brazilian regulators attribute the limited enforceability of the law to the lack of sufficient resources in government institutions to proceed with the administrative processes against every firm that does not follow the auction rules by the book (Tribunal de Contas da União, 2011). This parallels the "wrist slap hypothesis" in procurement fraud more generally, where government monitors often lack sufficient resources and skills to impose significant penalties on contractors. An OECD study substantiates this concern, finding that only 21% of countries have certification processes for public procurement officials. These deficiencies create vulnerabilities to fraud throughout the procurement process (OECD, 2019). Even when firms are suspended or debarred, the penalty may have little practical effect as the sanctioned entities can often circumvent punishments by creating new companies or operating as subcontractors (Gordon, 2019). Moreover, corporate lawyers argue against severe punishment for potential good-faith mistakes, citing the risk of overpricing in future auctions when the number of potential competitors gets reduced.[10]

3 Kamikaze Firms

Before we discuss the real non-market outcomes, we establish kamikaze behavior as a bid-rigging marker. In Section 3.1, we use three pieces of evidence to show that kamikaze behavior is associated with coordination among bidders. First, firms acting as kamikazes share owners and addresses with the eventual winners, and repeat these roles over time. Second, using a regression discontinuity design, we demonstrate that withdrawals occur significantly more likely when connected firms stand to benefit. Third, we show that a 2014 transparency reform that made ownership ties visible to auctioneers decreased overpricing and coordinated behavior.

In Section 3.2, we document that auctions with kamikaze firms, where lowest bidders withdraw shortly after winning, exhibit systematically higher prices and reduced competition compared to similar auctions. This overpricing is more pronounced when kamikaze and winning firms are connected, further suggesting strategic coordination.

[10]In Internet Appendix Section B, we highlight the difficulty in prosecuting kamikaze firms in a case study of an auction conducted by Brazil's National Institute for Colonization and Agrarian Reform (INCRA).

3.1 Coordination

We first turn to examine the linkages between kamikaze firms and eventual winners to ascertain whether withdrawals reflect coordination or "honest mistakes": kamikaze withdrawals can occur because the lowest bidder made a bidding error, suffered the winner's curse, or for non-strategic reasons failed to satisfy post-auction formalities. We define kamikaze behavior as cases where despite submitting the lowest bid firms are not awarded the procurement contract because they withdraw their bids, fail to deliver documents, or are disqualified due to inconsistencies.

3.1.1 Firm Connections: Shared Owners, Addresses, and Repeated Interactions

We provide descriptive evidence in line with coordination using kamikaze behavior by examining connections between kamikaze firms and auction winners using both observable corporate links and patterns of repeated interactions. Coordination predicts systematic relationships between kamikaze firms and the eventual winners in these auctions, while honest mistakes should produce random patterns with no consistent connections between specific firms. We match bidders to their geographic location and ownership structures using the Brazilian firm registry by *Receita Federal* to identify observable connections. Additionally, we track repeated kamikaze-winner partnerships across multiple procurement instances in the prior year to capture coordination that may occur through unobservable networks, as persistent relationships between the same firm pairs would indicate strategic coordination rather than random bidding errors.

For this test, we focus on non-kamikaze participants in auctions with kamikazes and estimate:

$$y_{ipj} = \alpha_{ip} + \beta \cdot X_{ipj} + e_{ipj} \tag{1}$$

where y_{ipj} is $p(winner)_{ipj}$, a dummy equal to 1 if bidder j at procurement i for item p is the winner and zero otherwise. The main explanatory variables, X_{ipj}, include indicators for whether firm j shares owners or addresses with the kamikaze firm, and whether firm j previously won an auction in the past year with the same firm currently acting as a kamikaze. This specification adds procurement-by-item fixed effects, which effectively compares the characteristics of firms participating in the same auction.

Table 2 presents the findings. Winning firms are systematically more likely to be connected to kamikaze firms than the other participants in the same procurement. Participants with at least one owner in common with the kamikaze firm are 7.82 percentage points more likely to win the procurements (column I), while those sharing an address with the kamikaze firm are 6.81 percentage points more likely to win the procurements. Finally, firms with established kamikaze partnerships, i.e., those that won auctions where the same firm acted as kamikaze within the last year, are 18.7 percentage points more likely to win the current auction (column III). Column IV tests whether these effects reflect learning rather than coordination by controlling for general prior winning experience and prior experience with any kamikaze firm. If firms were simply learning about kamikaze behavior, we would expect general kamikaze experience to predict success. However, adding prior wins with any kamikaze and prior wins in general as controls does not meaningfully change the magnitude of the repeat partnership coefficient: winning probability is still linked to relationships with particular kamikaze firms. Column V includes all connection variables simultaneously, and all three types of connections remain statistically significant, indicating that ownership ties, address sharing, and repeated partnerships represent distinct coordination mechanisms. These patterns are not explained by persistent or time-varying differences in bidder characteristics. Comparing auctions in which the same firm participates within the same year (i.e., by controlling for firm-year fixed effects), those auctions in which the firm shares ownership, an address, or a repeat partnership with the kamikaze are still won more often (Internet Appendix Table A2).[11]

To assess the prevalence of coordination in kamikaze behavior, we define coordinated kamikaze behavior as cases where at least one of these connection indicators is present: shared owners between kamikaze and winning firms, shared business addresses, or repeated partnerships. When defined this way, we can infer that 67% of kamikaze procurements exhibit observable coordination markers. It also suggests *ex-ante* coordination between winners and kamikaze firms. One alternative explanation could have been that kamikaze firms do not coordinate their behavior with the winning firms *ex-ante* but rather "blackmail" them *ex-post*. The overpricing then could reflect the anticipated side payment to the kamikaze firm. Given that kamikaze and winning firms are more likely to have systematic relationships, such arm's-length *ex-post* bargaining is less likely. The dropping out of the auction is also quite immediate (often within hours) which is unlikely with *ex-post* bargaining, unless it is quite sophisticated.

[11] Additionally, we find that kamikaze firms are systematically smaller and younger than winners, and maintain persistent roles across auctions—patterns consistent with special-purpose entities designed for coordination (Internet Appendix Section D provides details).

3.1.2 Regression Discontinuity Evidence of Strategic Coordination

We next turn to our first piece of causal evidence that isolates strategic incentives from honest mistakes. In particular, we set up a regression discontinuity design (RDD), which exploits quasi-random variation in who benefits from kamikaze withdrawals. We compare auctions held in the same year with the same firm having the lowest bid at the close, but that differ in the competition for the second place. In some auctions, a firm connected to the lowest bidder narrowly beats the unconnected firm for second place, while in others the ranking reverses. This leaves the lowest bidder with different ex-post incentives to withdraw: if withdrawals are strategic and coordinated, it should be more likely to withdraw when the connected firm finishes second rather than third.

To be more specific, we leverage the fact that Brazil's electronic reverse auctions end at a quasi-random time and focus on auctions with active bidding until the final moments (Ferraz et al., 2021).[12] When connected and unconnected firms[13] have nearly identical bids for second place, the identity of the firm just ahead when the auction ends is as-good-as-random from the kamikaze firm's perspective. This randomness is evidenced by the fact that looking back just 5 seconds from the auction's end, the firm that eventually became the second-lowest bidder was in second place 50% of the time, demonstrating that final rankings among closely competing firms are unpredictable. Therefore, any difference in withdrawal behavior must be due to the strategic value of benefiting connected firms rather than firm-specific traits that drive both connections and mistakes. Unconditionally, in this sample the lowest bidder withdraws 22% of the time when an unconnected firm is just ahead for second place and 33% when a connected firm is just ahead. The regression discontinuity formalizes this comparison by testing whether the gap is consistent when controlling flexibly for the bid gap.

We estimate the following specification:

$$\mathrm{y}_{ipt} = \alpha_{jt} + \beta \cdot \text{Connected Ahead}_{ipt} + f(\text{Bid Gap}_{ipt}) + e_{ipt} \tag{2}$$

y_{ipt} is an indicator for whether the lowest bidder withdraws in procurement i for item p. $ConnectedAhead_{ipt}$ is a dummy variable equal to one when the connected firm has the lower bid (is in second place), and zero otherwise. α_{jt} represents lowest-bidding firm j times year fixed effects, effectively comparing the same lowest bidding firm around the threshold. A

[12] We restrict our analysis to auctions with at least two bidders submitting bids in the final 30 seconds to ensure that final rankings reflect the unpredictable nature of auction endings rather than early strategic positioning.

[13] Note that our definition of connected firms is based on observables and some unconnected firms might be connected in real life, thus we are likely underestimating the effect.

connected firm is defined as a firm that shares ownership, addresses, or has had repeated partnerships with the kamikaze firm within the last year. Our running variable ($BidGap_{ipt}$) is the bid difference between connected and unconnected firms competing for second place: *(Connected firm's bid - Unconnected firm's bid).* $f(\cdot)$ is a flexible polynomial function of the running variable.

If withdrawals reflect honest mistakes, firms should be equally likely to withdraw regardless of whether a connected or unconnected firm would benefit. Thus, withdrawal rates should be smooth across the threshold ($\beta = 0$). However, we observe in Table 3 a sharp discontinuity at the threshold: the same lowest-bidding firm is 5.4 to 9.8 p.p. more likely to withdraw when the connected firm is barely ahead for second place compared to when the unconnected firm is barely ahead for second place. This represents a 25 to 45% increase relative to the 22% rate when an unconnected firm is ahead and is robust across different bandwidths (5%, 2.5%, and optimal). These findings are also presented in a visual format in Figure 4, and overall suggest that as kamikaze firms are more likely to withdraw when connected firm is ahead in the second place, the interpretation of honest mistakes is less likely and the such behavior suggests coordinated conduct.

3.1.3 Transparency Reform and Coordinated Kamikaze Behavior

As a second piece of plausibly exogenous evidence of coordination, we zoom into the shared ownership behavior and study a 2014 transparency reform introduced in the ComprasNet electronic procurement system. This reform allowed auctioneers to access information on participants with overlapping ownership, presumably increasing the costs of coordinating kamikaze behavior among firms with shared ownership. If shared ownership was not used for coordination and firms acted independently, we would not expect that auctioneer knowledge of shared ownership would affect participation of firms with shared ownership and eventual procurement outcomes.[14] However, as shown as model-free evidence in Figure 5, the fraction of public procurements with participants that shared ownership with other participants in the same auction dropped after 2014.[15] Based on this, we thus hypothesize

[14] In fact, the practice of allowing affiliated firms to participate in the same auction is common across jurisdictions. The European Court of Justice (Case C-538/07) and U.S. Government Accountability Office (B-183642, 1975; B-206080, 1982) have explicitly ruled that affiliated companies can submit separate bids in the same tender. This reflects the view that systematically excluding affiliated firms would reduce competition, and that ownership ties alone do not necessarily determine bidding behavior.

[15] Discussions with competition lawyers suggest 2014 as the effective enforcement date of this reform, coinciding with Brazil's anti-corruption law (Lei 12.846/2013), which imposed substantial fines for collusive bidding. Simultaneously, the Brazilian Federal Court of Accounts (or *Tribunal de Contas da União*, TCU) jurisprudence evolved to treat firms with shared ownership as potentially compromising competition, creating a decisive enforcement shift that altered firms' behavior.

an identifying assumption that firms which relied on shared ownership to coordinate their kamikaze strategies found such actions more costly after the reform and might have ceased their actions or turned into second-best strategies.

To analyze the impact of this transparency reform, we employ a difference-in-differences (DID) design. In particular, we compare procurement behavior and outcomes of the firms that relied on shared ownership to win kamikaze auctions before the reform and those that did not. Because the alert raised the cost of coordinating through shared ownership in particular, firms that depended on this strategy should have seen lower winning probability after 2014 relative to the firms that did not. We collapse the data into a firm-month panel and estimate the following specification:

$$y_{jt} = \alpha_j + \alpha_t + \beta \cdot \text{Shared Ownership}_j \cdot Post_t + e_{jt} \tag{3}$$

where j refers to the firm, and t to the year-month. The variable $Post_t$ equals one for $t \geq 2014$, and zero otherwise. $SharedOwnership_j$ represents the value-weighted fraction of kamikaze auctions won by firm j before 2014, in which it also shared ownership with a kamikaze firm. We initially look at three outcomes (y_{jt}): (i) the probability that firm j participates in an auction involving shared ownership with another participant; (ii) the probability that firm j wins an auction involving shared ownership with another participant; and (iii) the probability that firm j wins an auction that contains a kamikaze bidder.

We first validate this identification strategy by looking at whether after 2014 firms that relied on shared ownership with kamikazes in winning the procurement auctions reduced participation in auctions involving shared ownership with other participants. Figure 6 plots the event-study coefficients on Shared Ownership$_j$ for the probability of participating in an auction involving shared ownership with another participant. The estimates are flat and indistinguishable from zero before 2014, supporting the parallel-trends assumption. Only after 2014 can we see that the coefficients turn negative.

Table 4 presents the regression estimates from specification (3). For each coordination outcome we report two dependent variables: the probability $p(\cdot)$ that firm j engages in the behavior in a given month, and the share frac$(\cdot)$ of firm j's procurements that involve it. The evidence suggests that the introduction of the alert may have reduced coordinating behavior. Columns I-II provide the pooled regression estimates for Figure 6. In particular, Column I shows that treated firms' probability of participating in an auction involving shared ownership with another participant declines substantially after the reform: a 10 percentage point increase in Shared Ownership$_j$ is associated with a 1.58 percentage point reduction, and the corresponding share falls by 1.1 percentage points (Column II). Columns III and IV show the same for *winning* such an auction, with reductions of 0.65 and 0.18 percentage points, respectively. For winning an auction that contains a kamikaze bidder, the effect on the probability is negative but not statistically significant (Column V), whereas the share of a firm's auctions won alongside a kamikaze declines significantly (Column VI). Taken together, these findings suggest that shared ownership was likely used to coordinate the behavior between the kamikaze and winner firms.

3.2 Price Effects

Having established that kamikaze behavior predominantly reflects strategic coordination, we now test whether this coordination generates overpricing effects.

3.2.1 Kamikazes and Overpricing

We first document overpricing by comparing outcomes in auctions with and without kamikazes. We implement the following specification:

$$y_{ipt} = \alpha_{pt} + \alpha_{X_i t} + \beta \cdot \text{Has Kamikaze}_{ipt} + e_{ipt} \tag{4}$$

Has Kamikaze$_{ipt}$ equals 1 if a firm has the lowest bid but does not win procurement i for item p in year t, and 0 otherwise. y_{ipt} is the logarithm of the price for item p procured in procurement i at time t. α_{pt} are item-by-year fixed effects; $\alpha_{X_i t}$ are interactions of other procurement i characteristics (X_i) and year fixed effects such as number of genuine participants-by-year fixed effects and government institution-by-year fixed effects.

Table 5 presents the estimates of the specifications in which the outcome variable is the logarithm of the procured price. Column I reveals that auctions with kamikaze firms have 11.7% higher prices than other similar auctions for the same items, the same number of bidders, and occurring in the same year. To address the alternative that this overpricing is not due to some government institutions or auctioneers being less efficient, we further compare auctions for the same institution-year in column II and same auctioneer-year in column III. Even after adding these controls, the kamikaze behavior is still associated with a 9.3-9.7% price increase, suggesting that the presence of kamikaze firms significantly drives up costs, regardless of the procuring institution's efficiency.[16]

[16] In Internet Appendix Figure A5, we progressively remove auctions below different value thresholds and conclude that the kamikaze effect on prices remains stable (8.2% when excluding the bottom half of procurements versus 11.7% in the benchmark specification), and that they are not driven by small-value auctions. Furthermore, Internet Appendix Figure A6 shows that the kamikaze overpricing effect is relatively stable throughout the sample, apart from a drop in magnitude in 2014, possibly due to the transparency reform discussed in Section 3.1.3.

We next address several alternative explanations for this overpricing. One possibility is that higher prices could reflect market composition rather than the kamikaze strategy itself: withdrawals may be more common in markets with more entrants or fewer incumbents. To address this, column I of Internet Appendix Table A3 compares auctions with the same number of incumbents (firms that participated in procurements for the same product in the past year). The effect is barely affected: prices still increase by 8.8% in kamikaze auctions. Still, it could be that these incumbents are not strong contenders to win the contract. Column II, therefore, controls for the number of past non-kamikaze winners in the previous year. The coefficient is slightly larger, at 10.1%, indicating that the overpricing is not driven by differences in the presence of strong competitors. Columns III and IV repeat columns I and II while additionally controlling for the average age and size of the genuine bidders, and the results remain virtually identical, suggesting that the overpricing is not driven by kamikaze auctions featuring systematically less established or smaller competitors.

Moreover, unobserved characteristics of particular institutions or items could jointly drive both the incidence of kamikaze behavior and higher prices. If such a factor were behind our estimates, the overpricing should be concentrated in those cases when kamikaze behavior has been overall prevalent in the past. To examine this possibility, we measure kamikaze prevalence separately across institutions and across items.[17] Internet Appendix Table A6 shows that the overpricing does not vary significantly between institutions or items with a high versus low incidence of kamikaze auctions.[18] Finally, Internet Appendix Table A7 compares the same lowest-bidding firm across its own auctions and finds prices 10.3% higher when that firm withdraws than when it does not, suggesting that selection into particular auction characteristics is an unlikely driver.

While these tests cannot definitively rule out every possible confounder, they substantially narrow the range of alternative explanations and point to the kamikaze behavior as the most plausible explanation for overpricing.

3.2.2 Decomposing Overpricing

We next turn to the sources of this overpricing. One possibility is that kamikaze bidding deters more efficient bidders from active competition and results in different ranking of bidders than otherwise. The second possibility is that the ranking does not change but the most efficient bidder is able to extract higher rents. Our findings are consistent with

[17] Internet Appendix Tables A4 and A5 list items and institutions with high and low kamikaze prevalence.

[18] In Internet Appendix Table A6, we also show that overpricing does not differ when we compare purchases by federal and local governments. These findings reinforce the notion that institution-specific characteristics or item types do not seem to significantly explain the overpricing effect.

kamikaze bidding weakening competition, which in turn affects which firm wins. When genuine bidders face a very low bid, they cannot distinguish from genuine competition and compete less aggressively, making it more likely that a less efficient and likely connected firm wins the contract at a higher price.

We show this empirically by comparing procurements within the same eventual winner (i.e., when controlling for winner-by-item-by-year fixed effects in Panel B of Table 5), the overpricing falls from 9.3-11.7% to 3.1-3.5% (columns I and II) but remains statistically significant. This effect stays positive and significant when we additionally hold the auctioneer fixed effects (column III), so it cannot be explained by a particular buyer or auctioneer favoring that firm. This suggests most of the overpricing operates through *which* firm wins, while an effect persists even for the same firm.[19]

Consistent with weaker competition potentially explaining this selection, non-kamikaze bidders behave less aggressively when a kamikaze is present: they submit roughly 0.9 to 1.1 fewer bids per bidder and display 3–5% lower normalized bid dispersion (Internet Appendix Table A8). To further support the interpretation of less aggressive bidding, we analyze the bidding behavior of runner-up firms (genuine second-place bidders after kamikaze firms drop out). Internet Appendix Table A9 provides empirical evidence of a larger gap between runner-up and winning bids in kamikaze auctions compared to non-kamikaze auctions, indicating that runner-up firms bid less aggressively when kamikaze firms are present. Collectively, these findings indicate that the presence of kamikaze firms is associated with lower competition and that a substantial fraction of overpricing is associated with the selection of a less efficient contractor.

In Internet Appendix C we provide an illustrative theoretical framework justifying how less efficient firms might win with the help of kamikaze bidders. In our framework, kamikaze bids create uncertainty: when genuine bidders observe extremely low kamikaze bids, they cannot distinguish real competition from bids intended to be withdrawn. Combined with fixed bidding costs, such as investing resources to participate in the auction, this uncertainty deters competitive bidding behavior. Some competitors exit the auction entirely, believing they cannot compete with such low bids. Others remain, but bid less aggressively, anticipating reduced overall competition. We find empirical evidence consistent with these assumptions. First, overpricing is further exacerbated when there are simultaneous auctions of similar products, likely implying larger fixed costs. For example, capacity-constrained firms must decide how to allocate their limited resources across multiple auctions, making them less

[19]Another explanation for the lower within-winner estimate is that these winners use other bid-rigging strategies in non-kamikaze auctions, so the control observations may also involve bid-rigging; this would still imply that firms find kamikaze a more effective technique in this institutional environment.

willing to respond aggressively to kamikaze bids when they could instead focus their efforts on other ongoing auctions. Second, when multiple kamikaze firms participate in the same auction, they create a more genuine appearance of competition, thus also invoking higher uncertainty about whether the bids are legitimate. These cases are then associated with higher prices, as regular bidders perceive a lower chance of winning and bid less aggressively.

3.2.3 Coordination and Overpricing

Finally, we document that overpricing is indeed stronger with coordination. We re-estimate equation (4) by interacting the *Has Kamikaze* dummy with the dummy on whether kamikaze firms and winner firms are connected, i.e., either have shared ownership, shared addresses, or repeated past interactions. Table 6 presents the estimates. Columns I and II show that procurements with shared owners and kamikazes are 7.25-9.93% more overpriced than procurements with kamikaze firms but without sharing owners with winning firms, representing 75-85% of the unconditional effect of having a kamikaze firm in an auction. Moreover, columns III and IV show that sharing the same address increases overpricing by 3.4-5.2%, representing up to 44% of the unconditional effect of having a kamikaze firm in an auction. For repeated partnerships, kamikaze auctions with established partnerships (upper quartile of partnership intensity) exhibit 5.6-5.8% higher overpricing than those without such history, representing 56-67% of the unconditional kamikaze effect (columns V and VI). Thus, overpricing is systematically higher when kamikaze-winner pairs have connections.

We also study the effect of the transparency reform, described in Section 3.1.3, on prices. We estimate an analogous DID specification (3) with the logarithm of unit price for item p in procurement i as the outcome (as we cannot aggregate prices across different products, instead of firm-by-month panel, here we use a more granular firm-by-product panel with firm and product-by-year fixed effects). If coordination through shared ownership did not increase prices, then raising the cost of this strategy should not affect the prices of procurements where treated firms participate. Instead, column VII of Table 4 shows that the introduction of the shared-ownership alert decreased the prices charged in procurements after 2014: a 10 p.p. larger $SharedOwnership_j$ is associated with an approximately 1.6% decrease in the price of the same item around the reform. That prices fell precisely for the firms most reliant on shared ownership coordination, once that channel became more costly, suggests that this coordination was likely a causal driver of the overpricing documented above.

All in all, both the evidence from interacting kamikaze behavior with connections and more importantly evidence from transparency reform suggest that connections with kamikaze firms enable less-efficient firms to have higher prices in Brazilian procurement auctions.

4 Real Non-Price Effects

This paper has so far shown the coordinated nature of kamikaze behavior and also that it has a strong effect on the prices of items purchased by government institutions. We further discuss how such kamikaze behavior is related to real non-market outcomes, i.e., going beyond product markets, labor markets, or financial markets. We argue that such effects can happen through the selection of less efficient contractors. The quality of public services can be compromised because the winners in kamikaze auctions are not necessarily the most efficient firms with the highest-quality suppliers. This, in turn, hampers public institutions from delivering high-quality public services. We study this by examining service quality in terms of the cost overruns and the days of contract completion across all auctions in our data. We then investigate the real effects in two particular sectors: road accidents that are likely to occur due to lower-quality road maintenance by the winners of kamikaze auctions, and hospital mortality rates following the procurement of essential medicines by kamikaze firms. Finally, we show that these negative effects are significantly stronger when the kamikaze and winning firms are connected, providing evidence that the capacity to coordinate is associated with worse service quality.

4.1 Contract Quality

We study the contract execution of kamikaze auctions, where the lowest bidder withdrew after winning and the contract went to the second-lowest bidder. We observe information at the procurement-firm level regarding whether the government institution canceled the contract after it was signed with the auction winner, the amount of cost overruns, the difference between predicted and actual payments, and the days until contract completion. We estimate the following regression:

$$y_{ijt} = \alpha_i + \beta \cdot \text{Has Kamikaze}_{ijt} + e_{ijt}, \tag{5}$$

where y_{ijt} are contract quality outcomes for procurement i, with winner firm j at time t. Has Kamikaze$_{ijt}$ is a dummy equal to 1 if procurement i, firm j, time t had a kamikaze firm and 0, otherwise. We add procurement fixed effects (α_i) to compare outcomes across items within the same procurement notice.

We compare these outcomes for procurements with and without kamikaze firms in Panel A of Table 7. Panel A shows that procurements influenced by kamikaze bids are 5.8 p.p. more likely to be canceled by the procuring institution due to incomplete execution. Beyond cancellation, we also observe partial under-delivery: procurements with kamikaze bids are

7.3 p.p. more likely to record a confirmed delivery value strictly below the committed contract value, indicating that the supplier delivered less than what was contractually promised without the contract being formally canceled. We also find a 0.8 p.p. greater chance of cost overruns, measured as additional funds committed beyond the original contract value. Lastly, these procurements commonly encounter extended delays, with 6.9% longer delivery timelines than that of comparable procurements without kamikaze bids.

As discussed before, one concern is that these contract-quality differences may be driven by honest mistakes rather than deliberate coordination. The second-lowest bidder then inherits the contract, and observed under-delivery might simply reflect that this unintended winner is a lower-quality firm than the original lowest bidder. Panel B of Table 7 addresses this by showing that quality deterioration is substantially larger when the kamikaze firm and the winner are connected. Auctions where kamikaze and winners are connected are 7.8 p.p. more likely to be canceled and 9.8 p.p. more likely to be under-delivered, compared to 3.8 p.p. and 4.7 p.p. for unconnected kamikaze auctions. Similarly, delivery delays are 8.7% longer in connected kamikaze auctions versus 5.0% in unconnected ones. The significantly different coefficients indicate that coordination amplifies the contract-quality deterioration beyond what the honest withdrawals alone would predict.

4.2 Road Accidents

We first look at the effects on road quality as a real outcome of bid-rigging in kamikaze auctions. We take information from 1,061 road repair contracts. Of these, 389 were awarded in kamikaze auctions and 672 in non-kamikaze auctions. We then compare road accidents from *Polícia Rodoviária Federal* data following the road repairs that involve kamikaze auctions and those that do not involve kamikaze auctions. That is, for each road repair with kamikaze auction, we select non-kamikaze road repairs awarded in the same quarter as a control group.

To directly measure quality differences in road repairs, we conduct a cross-sectional analysis comparing the timing of when the road maintenance gets recontracted for new maintenance. We compare the timing for kamikaze and non-kamikaze road repairs in Panel A of Table 8. Using procurement data, we find that 36% of the roads in our sample undergo more than one repair, and among these roads requiring multiple repairs, subsequent maintenance occurs 3.5 years after the previous maintenance work. However, roads repaired through kamikaze auctions require subsequent maintenance 25.8% sooner than this standard cycle (column I), representing about 0.93 years earlier maintenance (column II). Columns III and IV show that kamikaze auctions also increase the probability of requiring any further maintenance by 10.7 p.p. and the probability of early recontracting (within 3 years, which is the median in our sample) by 21 p.p. According to established industry guidelines (Minnesota Department of Transportation, 2000), properly executed road surface maintenance treatments typically last between 3 and 8 years, depending on the specific method used. This shortened lifespan in kamikaze auction projects suggests that the firms ultimately winning these contracts are less qualified to provide quality services, despite charging higher prices than would have resulted from genuine competitive bidding.

These quality deficiencies are reflected in increased safety incidents. Panel B of Table 8 shows the estimates comparing accidents between road maintenance contracts awarded in kamikaze versus non-kamikaze auctions using a "stacked" DID approach (e.g., Gormley and Matsa, 2011; Cengiz et al., 2019; Deshpande and Li, 2019):

$$y_{iet} = \alpha_{ie} + \alpha_{et} + \beta \cdot \text{Kamikaze Auction}_{ie} \cdot Post_{et} + u_{iet}, \tag{6}$$

where y_{iet} refers to the road accidents or victims on road i in cohort e at time t. *Kamikaze* $Auction_{ie}$ is a dummy equal to one if the procurement for road construction i for cohort e is a kamikaze auction and zero otherwise. $Post_{et}$ is a dummy equal to one after the purchase in cohort e and zero otherwise. We control for cohort-by-road fixed effects and road extension-by-cohort-by-year fixed effects. In addition, we control for the length of the road extension which compares maintenances of similar complexity.

For this analysis, we distinguish between two types of accidents: (1) those caused by road fault conditions: including potholes, uneven pavement, poor signage, inadequate lighting, slippery surfaces, among others; and (2) those not due to road conditions, such as speeding, drunk driving, and distracted driving.[20] The findings reported in column I show that roads maintained by kamikaze auction winners are associated with a 13.7% higher number of accidents due to road conditions, while column III shows a 9.6% increase in victims from such accidents. At the same time, columns II and IV report that kamikaze auctions have no significant effect on non-road-fault accidents or their victims. This non-effect on non-road-fault accidents suggests that alternative reasons unrelated to kamikaze auctions that could explain the increase in accidents in these areas, such as changes in driver behavior or increased traffic, are unlikely.

One identification challenge is that kamikaze contracts could have been systematically awarded to roads already experiencing worsening accident trends, and so our estimates would capture these pre-existing differences rather than effects of maintenance quality. Panel A of Figure 7 shows that the effect on accidents due to road conditions only comes after the pur-

[20] Internet Appendix Table A10 presents a list of the accident causes from Brazil's Federal Highway Patrol.

chase and that there are no clear diverging trends before the procurement. The combination of parallel pre-trends and the effects being concentrated among road-fault accidents in Table 8 provides evidence that our findings are likely explained by lower-quality maintenance in contracts awarded through kamikaze auctions.

4.3 Hospital Mortality

In a second set of analysis of real non-price effects, we investigate hospital mortality for 61 federal hospitals in Brazil obtained from DataSUS. To identify whether bid-rigging behavior is associated with worse mortality rates, we look at hospital-disease pairs where a high proportion of emergency room medication purchases are made in kamikaze procurement auctions.[21] For each of these hospital-disease pairs, we select control hospital-disease pairs that purchase emergency room medications in the same quarter that are not predominantly made in kamikaze auctions. In the end, we have information from 34,782 essential medicines purchases. Of these, 1,527 were awarded in kamikaze auctions and 33,255 in non-kamikaze auctions. We then stack these events into cohorts and compare health outcomes around the purchase date in a "stacked" DID method using a specification analogous to equation (6), where y_{iet} refers to the mortality rate of hospital i in cohort e at time t. $\textit{Kamikaze Auction}_{ie}$ is a dummy equal to one if the procurement in hospital i for cohort e is a kamikaze auction and zero otherwise. $Post_{et}$ is a dummy equal to one after the purchase in cohort e and zero otherwise. We control for cohort-by-year fixed effects and hospital-by-cohort fixed effects, with the latter effectively accounting for time-invariant differences in hospital characteristics, such as hospital quality, allowing us to isolate the impact of kamikaze auctions on mortality.

Table 9, columns I and II, show that kamikaze auctions of essential medicines are associated with a 0.78-0.79 p.p. higher mortality rate for the particular cause, looking at 2- and 3-year windows around the event, respectively. This corresponds to an approximately 19% increase from the unconditional average mortality rate. These initial estimates are robust to time-invariant factors at the hospital-cause level and allow for comparisons of mortality rates across different hospitals for the same cause.

One alternative explanation of these findings is that hospitals experiencing kamikaze procurements might be simultaneously experiencing an unrelated decline in overall patient care effectiveness. To control for this, columns III and IV introduce additional controls in the form of hospital-cohort-year fixed effects. These controls account for any hospital time-varying factors that might influence mortality rates independently of whether the procurement had

[21] We classify hospital-disease pairs as "treated" when at least 90% of their purchases in the same quarter are made in kamikaze auctions. For each illness type, we take the essential medicines used to treat these diseases from the World Health Organization (2013) report and listed in Internet Appendix Table A11.

kamikaze incidence or not. That is, we identify the effect for the same hospitals in the same year across different medical causes that differed in the incidence of kamikaze auctions in the procurement of the medicine to treat these causes. The estimates from this more stringent specification remain robust. For the 2-year window (column III), the estimated effect slightly increases to 0.85 p.p., reinforcing our initial findings. In the 3-year window (column IV), the effect decreases to 0.53 p.p.

To further explore the impact of kamikaze auctions, we focus on the top three causes of mortality (infections, circulatory diseases, and respiratory diseases) in columns V and VI. We find even larger estimates, ranging from 0.93 to 1.09 p.p. This represents an increase of 10-11% from the unconditional average mortality rate for the main causes. These findings suggest that kamikaze auctions may have a particularly pronounced impact on the most critical medical supplies.

Finally, we investigate whether the trends in the mortality outcomes are different for hospitals with kamikaze auctions compared to those without them before the respective auctions. In Panel B of Figure 7, we provide a visual representation of the effect of kamikaze auctions on hospital mortality that tests the parallel trends assumption. The graph shows that the differences in the mortality rates are only observable after the occurrence of the kamikaze auctions. Before these auctions, treated and control hospitals seemed to follow similar trends, providing support to our identification strategy.

The mechanism through which kamikaze auctions affect hospital mortality likely operates through drug-disease-specific supply disruption. Because essential medicines have precise specifications and do not vary in quality across suppliers, the effect is unlikely to reflect inferior drug quality. Instead, colluding winners likely deliver essential medicines later or fail to deliver altogether: as discussed in Section 4.1, our contract quality results show that kamikaze auction winners experience 6.9% longer delivery times and 5.7 p.p. higher cancellation rates (Table 7), with even more severe delays when coordination is present. Restricting these contract-quality regressions to the hospital sample yields effects of comparable magnitude (4.8 p.p. higher cancellation, 6.0 p.p. more under-delivery, and 5.7% longer delivery times) confirming that the supply-disruption channel also operates within hospitals specifically (Internet Appendix Table A12). The inclusion of hospital-cohort-year fixed effects in columns III-IV of Table 9 means that the identifying variation is across diseases within the same hospital-year, ruling out hospital-wide explanations such as aggregate budget depletion.

With this in mind, we conduct two additional falsification tests based on the drug-disease specificity (Internet Appendix Table A13). First, we replicate the mortality specification but replace essential medicine kamikaze exposure with kamikaze exposure in non-essential procurement categories, including office supplies, IT equipment, construction materials, and vehicles. If the mortality effect operated through hospital-wide budget depletion or institutional dysfunction, kamikaze in auctions for non-essential supplies should also predict higher mortality. The coefficients are small and statistically insignificant (columns I-II), indicating that only drug-specific procurement disruption matters. Second, we assign each essential medicine to diseases it does *not* treat: for example, a cardiovascular drug is assigned to respiratory disease mortality. If the effect is drug-disease-specific, this misassignment should produce null effects. The coefficients are again insignificant and opposite in sign to the main effect (columns III-IV), confirming that the mortality increase is tied to the specific drug-disease pair affected by kamikaze procurement, not to broader hospital-level shocks.

4.4 The Role of Coordination

Finally, as in the previous analysis, we split the *Has Kamikaze* indicator by whether the kamikaze firm and the eventual winner are connected (sharing ownership, addresses, or repeated partnerships) or unconnected. One could be concerned that kamikazes self-select into particular procurements that due to unrelated reasons turn out to be associated with lower quality. Yet both connected and unconnected kamikaze auctions share the same observable feature — the lowest bidder withdraws — and are therefore subject to similar selection concerns. If real effects are driven by selection of kamikaze firms into certain auctions, both connected and unconnected kamikaze auctions should show similar effects.

However, as shown in Table 10, the effects concentrate in connected pairs. For road accidents (columns I-II), connected auctions have a 42 log-point increase in road-fault accidents versus 12 log points for unconnected pairs. For hospital mortality (columns III-IV), the effects are also concentrated in connected pairs: connected kamikaze auctions are associated with a 1.05 p.p. increase in mortality (significant at 1%), while unconnected kamikaze auctions show a statistically insignificant effect (0.2 p.p.). This pattern suggests that coordination and the associated selection of less efficient contractors is a critical factor in the severity of the resulting public harm, rather than the withdrawal event per se.

5 Discussion and Conclusion

This study documents that bid-rigging in public procurement auctions is associated with both overpricing and worse quality of public services. We use the kamikaze strategy as a bid-rigging marker and show that this tactic, observed in about 17% of Brazilian procurement auctions, inflates prices by 9.3-11.7% and often involves firms that share common owners and business addresses. Beyond fiscal costs, this behavior affects real outcomes primarily through the selection of less efficient contractors, as evidenced by worse contract performance. Ultimately, we document that kamikaze auctions correlate with more road accidents following maintenance services and increased hospital mortality rates. Our findings highlight the broader implications of bid-rigging in public procurements on public service provision, and that resource misallocation arising endogenously from collusion could have negative externalities on the ability to provide essential services to the public.

Our findings about the effects of bid-rigging have broader implications not limited to the specific auction format we study. First, electronic open-bidding formats like the one we study are increasingly common: more than 50 countries have adopted some form of e-procurement with open real-time bidding, including in South Korea, India, Chile, and across the European Union (Bosio et al., 2022). Yet, even in sealed bid auctions, firms coordinate through various strategies, such as bid rotation (Kawai et al., 2023), market division (Pesendorfer, 2000), or complementary bidding (Porter and Zona, 1993; Bajari and Ye, 2003; Clark et al., 2018). The fundamental forces remain the same. Like the kamikaze strategy we document, where 67% of cases show observable coordination markers, these methods all raise prices, deplete public budgets, and favor bid-rigging firms over potentially more efficient providers. Whether through explicit coordination or strategic deterrence, successful collusion generates similar harmful effects. Thus, our findings on mortality and infrastructure quality illustrate channels through which collusion can harm public services, channels that are plausibly present in other procurement settings.

Our general findings are likely valid not only with other auction designs but also in countries with different institutional backgrounds. While Brazil's federal procurement system has documented weaknesses in detection and post-award enforcement, bid rigging is not, however, limited to emerging economies. Kawai and Nakabayashi (2022) document that firms exhibiting non-competitive behavior won 37% of Japanese government construction projects, U.S. Department of Transportation (2025) identify coordination via complementary bidding in roughly 50% of U.S. highway procurement cases, and cartel prosecutions in the European Union have uncovered long-running bid-rigging schemes in sectors ranging from trucks to construction (Baránek et al., 2021). In cases with tighter post-award monitoring such as U.S. federal contracting, where the Contractor Performance Assessment Reporting System systematically records contractor performance and feeds into future award decisions (Carril et al., 2026), the quality deterioration we document may be attenuated, since tighter monitoring raises the expected cost of under-delivery. Our findings suggest that the welfare cost of collusion is larger where transparency is weaker, and that not only strengthening performance monitoring but also transparency on auction participants is particularly valuable in ensuring the quality of public service delivery.

We conclude with a few policy recommendations. First, it documents that more transparency on ownership ties among auction participants can raise the costs of implementing bid-rigging strategies. This finding supports policies that improve data-sharing practices, particularly with auctioneers involved in the procurement process, but also perhaps with other auction participants. As suggested by our simplified framework that rationalizes the empirical findings, reducing information asymmetry by flagging connected participants would allow other participants to reevaluate their bidding strategies. Second, and more broadly, our findings suggest that antitrust authorities could be granted direct mandates to consider non-market outcomes — such as public health and infrastructure quality — in their investigations. Expanding the scope of antitrust supervision would more effectively address the significant negative spillovers of bid-rigging in public procurements.

References

Andreyanov, P., A. Davidson, and V. Korovkin (2018). Detecting Auctioneer Corruption: Evidence from Russian Procurement Auctions. Working Paper.

Ashtari Tafti, E. and T. Hoe (2022). Killer Deals? The Impact of Hospital Mergers on Clinical Quality. Working Paper.

Asker, J. (2010). A Study of the Internal Organization of a Bidding Cartel. *American Economic Review 100*(3), 724–762.

Azar, J., M. Schmalz, and I. Tecu (2018). Anticompetitive Effects of Common Ownership. *Journal of Finance 73*(4), 1513–1565.

Bajari, P. and L. Ye (2003). Deciding between Competition and Collusion. *Review of Economics and Statistics 85*(4), 971–989.

Baránek, B., L. Musolff, and V. Titl (2021). Detection of Collusive Networks in E-procurement. Working Paper.

Barkley, A. (2023). The Human Cost of Collusion: Health Effects of a Mexican Insulin Cartel. *Journal of the European Economic Association 21*(5), 1865–1904.

Best, M. C., J. Hjort, and D. Szakonyi (2023). Individuals and Organizations as Sources of State Effectiveness. *American Economic Review 113*(8), 2121–2167.

Bosio, E., S. Djankov, E. L. Glaeser, and A. Shleifer (2022). Public Procurement in Law and Practice. *American Economic Review 112*(4), 1091–1117.

Brogaard, J., D. Coviello, Y. Huang, and S. Manfredonia (2026). Antitrust Enforcement and Product Market Dynamics: Evidence from U.S. Government Procurement. Working Paper.

Calonico, S., M. D. Cattaneo, and R. Titiunik (2014). Robust Nonparametric Confidence Intervals for Regression-Discontinuity Designs. *Econometrica 82*(6), 2295–2326.

Carril, R., A. Gonzalez-Lira, and M. S. Walker (2026). Competition under Incomplete

Contracts and the Design of Procurement Policies. *American Economic Review 116*(2), 535–581.

Cengiz, D., A. Dube, A. Lindner, and B. Zipperer (2019). The Effect of Minimum Wages on Low-Wage Jobs. *Quarterly Journal of Economics 134*(3), 1405–1454.

Charoenwong, B. and K. Asai (2020). Ownership Networks and Bid Rigging. Working Paper.

Chassang, S., K. Kawai, J. Nakabayashi, and J. Ortner (2022). Robust Screens for Noncompetitive Bidding in Procurement Auctions. *Econometrica 90*(1), 315–346.

Clark, R., D. Coviello, J. F. Gauthier, and A. Shneyerov (2018). Bid Rigging and Entry Deterrence in Public Procurement: Evidence from an Investigation into Collusion and Corruption in Quebec. *Journal of Law, Economics, & Organization 34*(3), 301–363.

Decarolis, F. (2014). Awarding Price, Contract Performance, and Bids Screening: Evidence from Procurement Auctions. *American Economic Journal: Applied Economics 6*(1), 108–132.

Department of Justice (2021). Price Fixing, Bid Rigging, and Market Allocation Schemes: What They Are and What to Look For. Antitrust Primer.

Deshpande, M. and Y. Li (2019). Who Is Screened Out? Application Costs and the Targeting of Disability Programs. *American Economic Journal: Economic Policy 11*(4), 213–248.

di Giovanni, J., M. García-Santana, P. Jeenas, E. Moral-Benito, and J. Pijoan-Mas (2024). Buy Big or Buy Small? Procurement Policies, Firms' Financing, and the Macroeconomy. Working Paper.

Duchin, R. and D. Sosyura (2012). The Politics of Government Investment. *Journal of Financial Economics 106*(1), 24–48.

Eliason, P., B. Heebsh, R. McDevitt, and J. Roberts (2019). How Acquisitions Affect Firm Behavior and Performance: Evidence from the Dialysis Industry. *Quarterly Journal of Economics 135*(1), 221–267.

Engelbrecht-Wiggans, R. and R. J. Weber (1979). An Example of a Multi-Object Auction Game. *Management Science 25*(12), 1272–1277.

European Commission (2002). Prevention, Detection and Elimination of Abnormally Low Tenders in the European Construction Industry. Technical Report.

Faccio, M., R. W. Masulis, and J. J. McConnell (2006). Political Connections and Corporate Bailouts. *Journal of Finance 61*(6), 2597–2635.

Fazio, D. (2026). The Two Sides of Discretion: Assessing Efficiency and Quality in Government Purchases. Working Paper.

Ferraz, C., F. Finan, and D. Szerman (2021). Procuring Firm Growth: The Effects of Government Purchases on Firm Dynamics. Working Paper.

Goldman, J. (2020). Government as Customer of Last Resort: The Stabilizing Effects of Government Purchases on Firms. *Review of Financial Studies 33*(2), 610–643.

Gordon, N. (2019). Contractors Use Shell Games to Hide Owners, Cheat Taxpayers. Project On Government Oversight.

Gormley, T. A. and D. A. Matsa (2011). Growing Out of Trouble? Corporate Responses to Liability Risk. *Review of Financial Studies 24*(8), 2781–2821.

Gupta, A., S. Howell, C. Yannelis, and A. Gupta (2024). Owner Incentives and Performance in Healthcare: Private Equity Investment in Nursing Homes. *Review of Financial Studies 37*(4), 1029–1077.

Ha, S., F. Ma, and A. Žaldokas (2024). Motivating Collusion. *Journal of Financial Economics 163*, 103798.

Houde, J. F., T. R. Johnson, M. Lipscomb, and L. Schechter (2022). Imperfect Competition and Sanitation: Evidence from Randomized Auctions in Senegal. Working Paper.

Kawai, K. and J. Nakabayashi (2022). Detecting Large-Scale Collusion in Procurement Auctions. *Journal of Political Economy 130*(5).

Kawai, K., J. Nakabayashi, J. Ortner, and S. Chassang (2023). Using Bid Rotation and Incumbency to Detect Collusion: A Regression Discontinuity Approach. *Review of Economic Studies 90*(1), 376–403.

Kumar, V., R. C. Marshall, L. M. Marx, and L. Samkharadze (2015). Buyer Resistance for Cartel versus Merger. *International Journal of Industrial Organization 39*, 71–80.

Lewis-Faupel, S., Y. Neggers, B. A. Olken, and R. Pande (2016). Can Electronic Procurement Improve Infrastructure Provision? Evidence from Public Works in India and Indonesia. *American Economic Journal: Economic Policy 8*(3), 248–263.

Liscow, Z., W. Nober, and C. Slattery (2023). Procurement and Infrastructure Costs. NBER Working Paper 31705.

Liu, T. (2022). Bargaining with Private Equity: Implications for Hospital Prices and Patient Welfare. Working Paper.

Marshall, R. C. and L. M. Marx (2012). *The Economics of Collusion: Cartels and Bidding Rings*. MIT Press.

Minnesota Department of Transportation (2000). Best Practices Handbook on Asphalt Pavement Maintenance. Technical Report, Minnesota Department of Transportation.

OECD (2009). *Guidelines for Fighting Bid Rigging in Public Procurement*. OECD Publishing.

OECD (2019). *Reforming Public Procurement: Progress in Implementing the 2015 OECD Recommendation*. OECD Publishing.

Pecenco, M., C. Schmidt-Padilla, and H. Taveras (2024). Opportunities and Entrepreneurship: Evidence on Advanced Labor Market Experience. Working Paper.

Pesendorfer, M. (2000). A Study of Collusion in First-Price Auctions. *Review of Economic Studies 67*, 381–411.

Porter, R. H. (2005). Detecting Collusion. *Review of Industrial Organization 26*(2), 147–167.

Porter, R. H. and J. D. Zona (1993). Detection of Bid Rigging in Procurement Auctions. *Journal of Political Economy 101*(3), 518–538.

Porter, R. H. and J. D. Zona (1999). Ohio School Milk Markets: An Analysis of Bidding. *RAND Journal of Economics 30*(2), 263–288.

Schmalz, M. (2021). Recent Studies on Common Ownership, Firm Behavior, and Market Outcomes. *Antitrust Bulletin 66*(1), 12–38.

Schmalz, M. and J. Xie (2022). Do Corporations Maximize their Own Value? Working

Paper.

Schoenherr, D. (2019). Political Connections and Allocative Distortions. *Journal of Finance 75*(2), 543–584.

Spulber, D. F. (1990). Auctions and Contract Enforcement. *Journal of Law, Economics, & Organization 6*(2), 325–344.

Transparency International (2015). Transparency in Public Procurement. Technical Report.

Tribunal de Contas da União (2011). Acórdão n. 1793/2011. Plenário, TCU.

United States GAO (2013). Reverse Auctions: Guidance Is Needed to Maximize Competition and Achieve Cost Savings. Government Report GAO-14-108.

U.S. Department of Transportation (2025, February). Assessing competition in highway procurement. Technical report, U.S. DOT, Office of Inspector General.

Whinston, M. D. (2008). *Lectures on Antitrust Economics*. MIT Press.

World Health Organization (2013). WHO Model List of Essential Medicines. Technical Report.

Zheng, C. Z. (2001). High Bids and Broke Winners. *Journal of Economic Theory 100*(1), 129–171.

Table 1: Summary Statistics

	n	mean	std dev	p1	median	p99
Auction Variables						
$\log(\text{price})_{ipt}$	14,967,474	3.107	2.324	-2.303	2.996	9.401
Has Kamikaze$_{ipt}$	14,967,462	0.171	0.376	0.000	0.000	1.000
# Participants$_{ipt}$	14,967,474	6.838	5.509	1.000	5.000	165.000
# Kamikaze firms$_{ipt}$	14,967,464	0.357	1.095	0.000	0.000	54.000
# bids per bidder$_{ipt}$	14,913,088	4.263	5.510	1.000	2.060	33.500
$\sigma(bid)/\overline{bid}_{ipt}$	14,913,075	0.748	0.977	0.000	0.407	5.349
Has Shared Owners$_{ipt}$	14,967,474	0.020	0.139	0.000	0.000	1.000
Has Shared Address$_{ipt}$	14,967,474	0.030	0.172	0.000	0.000	1.000
Frac Repeat Partnership$_{ipt}$	2,586,304	0.084	0.146	0.000	0.0227	1.000
Auction-Participant Variables						
Repeat Partnership$_{ipj}$	19,362,473	0.381	0.486	0.000	0.000	1.000
Same Address$_{ipj}$	19,362,473	0.023	0.048	0.000	0.000	1.000
Same Owners$_{ipj}$	19,362,473	0.001	0.031	0.000	0.000	1.000
p(winner)$_{ipj}$	19,362,473	0.132	0.338	0.000	0.000	1.000
Procurement-Winning Firm Variables						
p(canceled)$_{ijt}$	571,931	0.192	0.394	0.000	0.000	1.000
p(cost overrun)$_{ijt}$	571,931	0.051	0.219	0.000	0.000	1.000
Payment/Predicted$_{ijt}$	571,931	0.602	0.591	0.000	0.643	3.815
log(days)$_{ijt}$	557,985	4.846	0.964	2.565	4.890	7.085
Hospital-Cause-Cohort Variables						
mortality (all)$_{iet}$	997,503	0.041	0.058	0.000	0.021	0.308
mortality (main)$_{iet}$	168,186	0.095	0.070	0.000	0.078	0.333
Road-Cohort Variables						
log(accidents)$_{iet}$ (road-fault)	28,207	2.218	1.111	0.000	2.303	4.477
log(accidents)$_{iet}$ (non-road-fault)	30,942	3.830	1.595	0.000	4.174	6.672
log(victims)$_{iet}$ (road-fault)	27,035	1.813	1.063	0.000	1.946	4.060
log(victims)$_{iet}$ (non-road-fault)	30,519	3.451	1.434	0.000	3.761	5.999

This table presents summary statistics for key variables (2005-2021). Subscripts i, p, t, and j denote procurement, item, time, and participating firm, respectively. Log(price)$_{ipt}$ is the purchase price logarithm. Has Kamikaze$_{ipt}$ indicates procurements that had firms that had the lowest bid but did not win the procurement because they did not satisfy the final formalities required to be declared the winner by, for instance, withdrawing, not submitting the required documents, or providing inadequate documentation. # Participants$_{ipt}$ and # Kamikaze firms$_{ipt}$ count bidders and kamikaze firms. # bids per bidder$_{ipt}$ and $\sigma(bid)/\overline{bid}_{ipt}$ measure bidding behavior and dispersion among non-kamikaze firms. Has Shared Owners$_{ipt}$, Has Shared Address$_{ipt}$, Same Address$_{ipj}$, Same Owners$_{ipj}$ capture observable relationships between bidders. Frac Repeat Partnership$_{ipt}$ measures the frequency of prior kamikaze-winner partnerships between the same firm pairs relative to the winner's total victories within the last year (variable calculated only for procurements with kamikaze behavior). Repeat Partnership$_{ipj}$ is a dummy variable indicating whether firm j has previously partnered with the kamikaze firm within the last year. P(winner)$_{ipj}$ is bidder j's winning probability. For winning firms, p(canceled)$_{ijt}$, p(cost overrun)$_{ijt}$, Payment/Predicted$_{ijt}$, and log(days)$_{ijt}$ measure execution outcomes. Hospital variables track mortality rates, while road variables measure accidents and victims by cause (road-fault vs. non-road-fault).

Table 2: Relationships between Kamikaze Firms and Winners

	p(winner)$_{ipj}$				
	I	II	III	IV	V
Same Owners$_{ipj}$	0.0782***				0.0522*
	(0.0219)				(0.0207)
Same Address$_{ipj}$		0.0681***			0.0378**
		(0.0142)			(0.0136)
Repeat Partnership$_{ipj}$			0.1875***	0.1843***	0.1842***
			(0.0021)	(0.0021)	(0.0021)
Repeat Win With Kami$_{ipj}$				0.0042*	0.0042*
				(0.0020)	(0.0020)
Repeat Win$_{ipj}$				0.0196***	0.0196***
				(0.0027)	(0.0027)
Obs	19,362,473	19,362,473	19,362,473	19,362,473	19,362,473
R^2	0.155	0.155	0.201	0.201	0.201
Procurement × Item FEs	Yes	Yes	Yes	Yes	Yes

This table examines whether firms with connections to kamikaze firms are more likely to win procurements. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. We estimate the following specification:

$$y_{ipj} = \alpha_{ip} + \beta \cdot X_{ipj} + e_{ipj}$$

where the dependent variable y_{ipj} is p(winner)$_{ipj}$ — a dummy equal to 1 if bidder j at procurement i for item p is the winner and zero otherwise. The independent variables are Same Owners$_{ipj}$, indicating whether firm j has the same owner as the kamikaze firm (column I), Same Address$_{ipj}$, indicating whether firm j shares the same address as the kamikaze firm (column II), and Repeat Partnership$_{ipj}$, indicating whether firm j and the current kamikaze firm have formed the same kamikaze-winner partnership in other auctions within the past 12 months (column III). Column IV includes Repeat Win With Kami$_{ipj}$, indicating whether firm j previously won any auction with any kamikaze firm in the past 12 months, and Repeat Win$_{ipj}$, indicating whether firm j won any auction in the past 12 months regardless of kamikaze presence. Column V includes all connection variables simultaneously. All columns control for Procurement-by-Item fixed effects (α_{ip}). The sample includes all participating firms except the kamikaze firms themselves, allowing us to test whether firms connected to kamikaze firms have a higher probability of winning compared to unconnected firms. Standard errors clustered at the firm level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 3: *Regression Discontinuity Based on Random Auction Ending*

	p(withdraw)$_{ipt}$					
	I	II	III	IV	V	VI
Connected Ahead$_{ipt}$	0.0982***	0.0747***	0.0838***	0.0633***	0.0725***	0.0540***
	(0.0045)	(0.0032)	(0.0042)	(0.0031)	(0.0042)	(0.0034)
Obs	326,113	326,113	260,019	260,019	160,016	160,016
R^2	0.677	0.784	0.678	0.783	0.649	0.766
Bandwidth	5%		2.5%		Optimal	
Firm × Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution × Year FEs		Yes		Yes		Yes

This table presents regression discontinuity estimates examining whether kamikaze firms are more likely to withdraw when connected firms would benefit from the withdrawal. We estimate the following specification:

$$\text{p(withdraw)}_{ipt} = \alpha_{jt} + \beta \cdot \text{Connected Ahead}_{ipt} + f(\text{Bid Gap}_{ipt}) + e_{ipt}$$

where the dependent variable p(withdraw)$_{ipt}$ is an indicator for whether the lowest bidder withdraws in procurement i for item p at time t. Connected Ahead$_{ipt}$ is a dummy equal to one when the connected firm has the lower bid (is in second place), and zero otherwise. Bid Gap$_{ipt}$ is the normalized bid difference between connected and unconnected firms competing for second place: (Connected firm's bid - Unconnected firm's bid). The sample includes auctions where connected and unconnected firms have very similar bids for second place, creating quasi-random variation in which type of firm would benefit from kamikaze withdrawal. The optimal bandwidth is based on the selection method from Calonico et al. (2014). Standard errors clustered at the firm level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 4: *Transparency Reform: Coordination Outcomes*

	Shared owner$_{jt}$		Win & shared owner$_{jt}$		Win & kamikaze$_{jt}$		log(price)$_{jpt}$
	$p(\cdot)$	frac$(\cdot)$	$p(\cdot)$	frac$(\cdot)$	$p(\cdot)$	frac$(\cdot)$	
	I	II	III	IV	V	VI	VII
Shared Ownership$_j$ x Post$_t$	−0.1584***	−0.1105***	−0.0646***	−0.0178***	−0.0161	−0.0065**	−0.1633**
	(0.0242)	(0.0165)	(0.0100)	(0.0027)	(0.0098)	(0.0021)	(0.0629)
Obs	5,861,016	5,861,016	5,861,016	5,861,016	5,861,016	5,861,016	20,263,016
R^2	0.121	0.094	0.085	0.039	0.178	0.036	0.942
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	
Item × Year FEs							Yes

This table presents difference-in-differences estimates of the introduction of the shared-ownership alert in the ComprasNet electronic procurement system (Section 3.1.3). We estimate

$$y_{jt} = \alpha_j + \alpha_t + \beta \cdot \text{Shared Ownership}_j \cdot Post_t + e_{jt}$$

on a firm-by-month panel for columns I–VI, and the analogous specification with firm and item-by-year fixed effects on a firm-by-product panel for column VII. Shared Ownership$_j$ is the value-weighted fraction of firm j's pre-2014 kamikaze-auction wins that occurred in procurements where it shared ownership with another participant. $Post_t$ equals 1 if $t \geq 2014$ and 0 otherwise. For each coordination outcome we report two dependent variables: $p(\cdot)$, an indicator equal to 1 if firm j took the action in at least one procurement in month t; and frac$(\cdot)$, the share of firm j's procurements in month t in which it did so. The outcomes are: sharing ownership with another participant (columns I–II); winning a procurement while sharing ownership with another participant (columns III–IV); and winning a procurement that contains a kamikaze bidder (columns V–VI). Column VII is the logarithm of the unit price. Columns I–VI include firm and year fixed effects, with standard errors clustered at the firm level. Column VII includes firm and item-by-year fixed effects, with standard errors two-way clustered at the firm and item levels. Standard errors in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 5: Kamikaze Firms and Pricing

	log(price)$_{ipt}$		
	I	II	III
Panel A: Main Specification			
Has Kamikaze$_{ipt}$	0.1174***	0.0970***	0.0935***
	(0.0054)	(0.0043)	(0.0040)
Obs	14,967,462	14,967,462	14,765,552
R^2	0.865	0.870	0.873
Item × Year FEs	Yes	Yes	Yes
# Genuine Bidders × Year FEs	Yes	Yes	Yes
Gov Institution × Year FEs		Yes	
Auctioneer × Year FEs			Yes
Panel B: Adding Winner Fixed Effects			
Has Kamikaze$_{ipt}$	0.0349***	0.0307***	0.0307***
	(0.0047)	(0.0050)	(0.0052)
Obs	14,965,838	14,965,838	14,763,960
R^2	0.928	0.930	0.930
Winner × Item × Year FEs	Yes	Yes	Yes
# Genuine Bidders × Year FEs	Yes	Yes	Yes
Gov Institution × Year FEs		Yes	
Auctioneer × Year FEs			Yes

This table compares procurement prices with and without the presence of kamikaze firms. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. We implement the following specification:

$$y_{ipt} = \alpha_{pt} + \alpha_{X_i t} + \beta \cdot \text{Has Kamikaze}_{ipt} + e_{ipt}$$

where y_{ipt} is the logarithm of the price for item p purchased in procurement i at time t, and Has Kamikaze$_{ipt}$ equals 1 if a firm has the lowest bid but does not win procurement i for item p in year t, and 0 otherwise. α_{pt} denotes item-year fixed effects and $\alpha_{X_i t}$ denotes interactions of procurement characteristics (X_i) with year fixed effects, namely the number of genuine bidders, the government institution, and the auctioneer. In both panels, column I adds Item-Year and # of Genuine Bidders × Year fixed effects, effectively comparing procurements with the same item purchased and the same number of non-kamikaze bidders in the same year. Column II also includes Gov Institution-Year fixed effects. Column III compares procurements run by the same auctioneer, adding Auctioneer-Year fixed effects. Panel B adds winner-by-item-by-year fixed effects so that the coefficient is identified from price variation for the same winning firm. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 6: *Kamikaze Firms and Pricing: Ownership, Address, and Partnership Effects*

	$\log(\text{price})_{ipt}$					
	I	II	III	IV	V	VI
Has Kamikaze$_{ipt}$	0.1163***	0.0964***	0.1163***	0.0966***	0.1034***	0.0839***
	(0.0054)	(0.0043)	(0.0054)	(0.0043)	(0.0044)	(0.0037)
Has Shared Owners$_{ipt}$	0.0959***	0.0702***				
	(0.0200)	(0.0158)				
Has Shared Owners & Kamikaze$_{ipt}$	0.0993$^+$	0.0725$^+$				
	(0.0537)	(0.0384)				
Has Shared Address$_{ipt}$			0.0457***	0.0212*		
			(0.0101)	(0.0099)		
Has Shared Address & Kamikaze$_{ipt}$			0.0521*	0.0341$^+$		
			(0.0256)	(0.0197)		
High Repeat Partnership$_{ipt}$					0.0589***	0.0563***
					(0.0056)	(0.0056)
Obs	14,967,462	14,967,462	14,967,462	14,967,462	14,967,462	14,967,462
R^2	0.865	0.870	0.865	0.870	0.865	0.870
Item × Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
# Genuine Bidders × Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution × Year FEs		Yes		Yes		Yes

This table extends the analysis of procurement auctions with and without the presence of kamikaze firms presented in Table 5 and focuses on how the effect of kamikaze firms on pricing varies with whether they share ownership and same business address with the winners. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. The dependent variable is the logarithm of the price for item p purchased in procurement i at time t. Has Kamikaze$_{ipt}$ is equal to 1 if procurement i for item p at time t has a kamikaze firm and 0, otherwise. Has Shared Owners$_{ipt}$ is a dummy equal to 1 if at least two firms in procurement i for item p in year t have the same owner. Has Shared Owners & Kamikaze$_{ipt}$ equals 1 if the kamikaze firm and the winning firm share the same owner in procurement i for item p at year t. Has Shared Address$_{ipt}$ is a dummy equal to 1 if at least two firms in the procurement share the same business address, and Has Shared Address & Kamikaze$_{ipt}$ equals 1 if the kamikaze firm and the winning firm share the same business address. High Repeat Partnership$_{ipt}$ is a dummy equal to 1 if the share of the winner's victories involving the same kamikaze firm is in the upper quartile within the past 12 months. Columns I, III, and V control for Item-by-Year and # Genuine Bidders-by-Year fixed effects. Columns II, IV, and VI also include Government Institution-by-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. See caption of Table 5 for further details of the specifications.

Table 7: Kamikaze Auctions and Contract Quality

	p(canceled)_{ijt}	$\text{p(cost overrun)}_{ijt}$	$\text{p(under-delivered)}_{ijt}$	$\log(\text{days})_{ijt}$
	I	II	III	IV
Panel A: Kamikaze vs Non-Kamikaze Auctions				
Has Kamikaze_{ijt}	0.0578***	0.0075***	0.0725***	0.0689***
	(0.0018)	(0.0008)	(0.0016)	(0.0025)
Obs	668,906	668,906	668,906	656,142
R^2	0.469	0.807	0.468	0.557
Procurement FEs	Yes	Yes	Yes	Yes
Panel B: Connected vs. Unconnected				
Has $\text{Kamikaze}_{ijt}\cdot\text{Connected}_{ijt}$	0.0775***	0.0109***	0.0978***	0.0872***
	(0.0024)	(0.0010)	(0.0021)	(0.0031)
Has $\text{Kamikaze}_{ijt}\cdot\text{Unconnected}_{ijt}$	0.0378***	0.0041***	0.0468***	0.0501***
	(0.0017)	(0.0007)	(0.0017)	(0.0028)
Wald test: connected = unconnected				
Difference	0.040***	0.007***	0.051***	0.037***
Obs	668,906	668,906	668,906	656,142
R^2	0.470	0.807	0.469	0.557
Procurement FEs	Yes	Yes	Yes	Yes

This table reports the effect of kamikaze bidding on contract-quality outcomes. Panel A estimates:

$$y_{ijt} = \alpha_i + \beta \cdot \text{Has Kamikaze}_{ijt} + e_{ijt},$$

where y_{ijt} are outcomes for procurement i with winner firm j at time t. The outcomes are: the probability that the contract is canceled (column I); the probability that the contract experiences a cost overrun, measured as whether additional funds are committed beyond the original contract value (column II); the probability that the contract is under-delivered, measured as whether the confirmed delivery value is strictly below the committed contract value (column III); and the logarithm of days from contract commitment to the last delivery confirmation (column IV). Panel B replaces the kamikaze indicator with separate interactions for kamikaze auctions where the winner is connected to the kamikaze firm (through shared ownership, a common registered address, or repeated partnerships within the past 12 months) and where it is not. All specifications include procurement fixed effects (α_i), comparing outcomes across items within the same procurement notice. Standard errors clustered at the government institution level are in parentheses. The Wald test reports the difference between the connected and unconnected coefficients, with stars indicating the significance level for the test that the two coefficients are equal. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 8: Kamikaze Road Repair Procurements and Road Accidents

Panel A: Recontract Time

	$\log(\text{years})_{ie}$	years_{ie}	p(recontr.)_{ie}	$\text{p}(< 3\ \text{years})_{ie}$
	I	II	III	IV
Kamikaze Auction_{ie}	-0.2582**	-0.9292***	0.1067***	0.2098**
	(0.0917)	(0.2352)	(0.0273)	(0.0670)
Obs	2,133	2,133	6,777	2,133
R^2	0.531	0.479	0.476	0.585
Road Extension × Cohort	Yes	Yes	Yes	Yes

Panel B: Accidents by Fault Type

	$\log(\text{accidents})_{iet}$		$\log(\text{victims})_{iet}$	
	Road	Non-Road	Road	Non-Road
	I	II	III	IV
Kamikaze $\text{Auction}_{ie} \cdot \text{Post}_{et}$	0.1370**	0.0088	0.0962^{+}	-0.0108
	(0.0469)	(0.0425)	(0.0507)	(0.0382)
Obs	28,207	31,250	27,035	30,880
R^2	0.927	0.973	0.893	0.971
Cohort × Road	Yes	Yes	Yes	Yes
Road Extension × Cohort × Year	Yes	Yes	Yes	Yes

This table compares outcomes between road repair contracts awarded via kamikaze vs non-kamikaze auctions. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. For each road maintenance contract awarded through a kamikaze auction (where the original lowest bidder withdrew), we select as controls road maintenance contracts awarded through standard competitive auctions (where the lowest bidder successfully won) that occurred in the same quarter. Panel A presents a cross-sectional comparison of recontracting outcomes. Panel B uses a stacked difference-in-differences design as in equation (6): Kamikaze Auction_{ie} is equal to 1 if the road repair was awarded in a kamikaze auction and 0, otherwise. Panel A presents a cross-sectional analysis of recontract timing. The dependent variables are logarithm of years until next recontract (column I); years until next recontract (column II); probability of being recontracted (column III); and probability of being recontracted within 3 years, i.e., the median in the sample (column IV). Panel B examines the effect on road accidents by fault type. The dependent variable y_{iet} is either the logarithm of the number of accidents in road repair i, cohort e and year t (columns I and II) or the logarithm of the number of victims (columns III and IV). Estimates are presented separately for road-fault accidents (columns I and III) and non-road-fault accidents (columns II and IV). Post_{et} is equal to 1 after the contracts were awarded and 0, otherwise. Road Extension refers to quintiles based on the length of the road, allowing us to control for road size. Standard errors clustered at the cohort level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 9: *Kamikaze Essential Medicine Procurements and Hospital Mortality*

	mortality rate$_{iet}$					
	All Causes				Top 3	
	I	II	III	IV	V	VI
Kamikaze Auction$_{ie}$·Post$_{et}$	0.0078***	0.0079***	0.0085*	0.0053^{+}	0.0093*	0.0109**
	(0.0020)	(0.0020)	(0.0033)	(0.0030)	(0.0039)	(0.0041)
Window	2y	3y	2y	3y	2y	3y
Obs	675,718	997,503	675,718	997,503	113,673	168,186
R^2	0.769	0.719	0.788	0.746	0.906	0.872
Hospital × Cohort × Cause	Yes	Yes	Yes	Yes	Yes	Yes
Cause × Cohort × Year	Yes	Yes	Yes	Yes	Yes	Yes
Hospital × Cohort × Year			Yes	Yes		

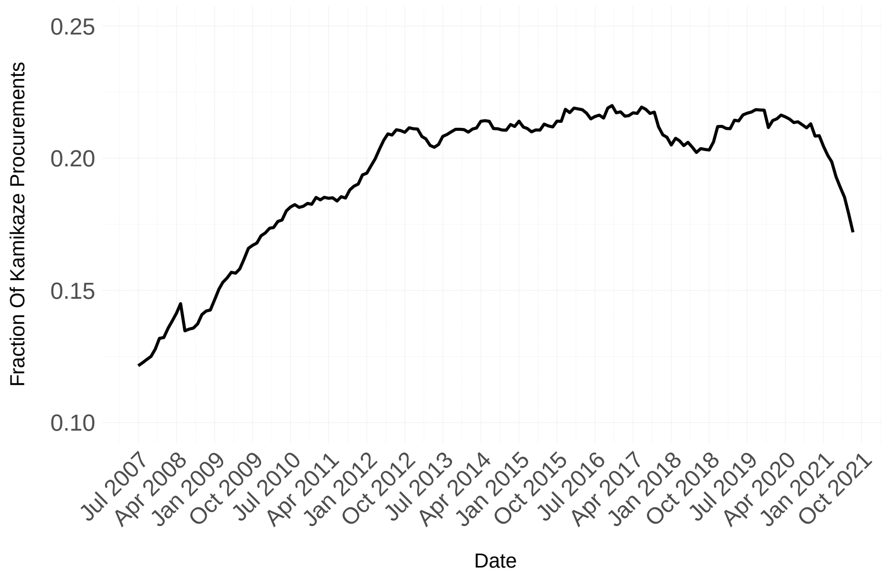
This table compares hospital mortality rates following essential medicine purchases via kamikaze versus non-kamikaze auctions. Kamikaze auctions are defined to be those auctions in which a kamikaze firm participated. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. We define treated hospital-cause-cohort observations as those in which at least 90% of essential-medicine purchases for the relevant disease in the quarter were made through kamikaze auctions. Control hospital-cause-cohort observations are those with essential-medicine purchases in the same quarter not predominantly made through kamikaze auctions. We stack these events in a "stacked" DID design as in equation (6), where the dependent variable y_{iet} is the ratio between deaths and number of inpatients in hospital i, cohort e and year t. The main independent variable Kamikaze Auction$_{ie}$ is equal to 1 if the purchase of essential medicine for hospital i in cohort e was made via a kamikaze auction and 0, otherwise. Post$_{et}$ is a dummy equal to one after the contracts were awarded and 0, otherwise. Columns I-IV present results for all causes, while columns V-VI focus on the top 3 causes. Odd-numbered columns use a 2-year window around each event, and even-numbered columns use a 3-year window. All regressions control for Hospital-Cohort-Cause and Cause-Cohort-Year fixed effects, with columns III and IV also including Hospital-Cohort-Year fixed effects. Standard errors clustered at the cohort level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 10: *Non-Market Real Outcomes and Coordination*

Real Outcomes	Road Accidents (Road-Fault)		Hospital Mortality (All Causes)	
	log(accidents)	log(victims)	mortality rate$_{iet}$	
	I	II	III	IV
Kamikaze Auction$_{ie}$·Post$_{et}$·Unconnected$_{ie}$	0.1187*	0.0825	0.002	-0.0055
	(0.0484)	(0.0534)	(0.0052)	(0.0048)
Kamikaze Auction$_{ie}$·Post$_{et}$·Connected$_{ie}$	0.4209**	0.2955*	0.0105**	0.0086*
	(0.1489)	(0.1221)	(0.0041)	(0.0036)
Window			2y	3y
Obs	28,207	27,035	675,718	997,503
R^2	0.927	0.892	0.788	0.746
Cohort × Road	Yes	Yes		
Road Extension × Cohort × Year	Yes	Yes		
Hospital × Cohort × Cause			Yes	Yes
Cause × Cohort × Year			Yes	Yes
Hospital × Cohort × Year			Yes	Yes

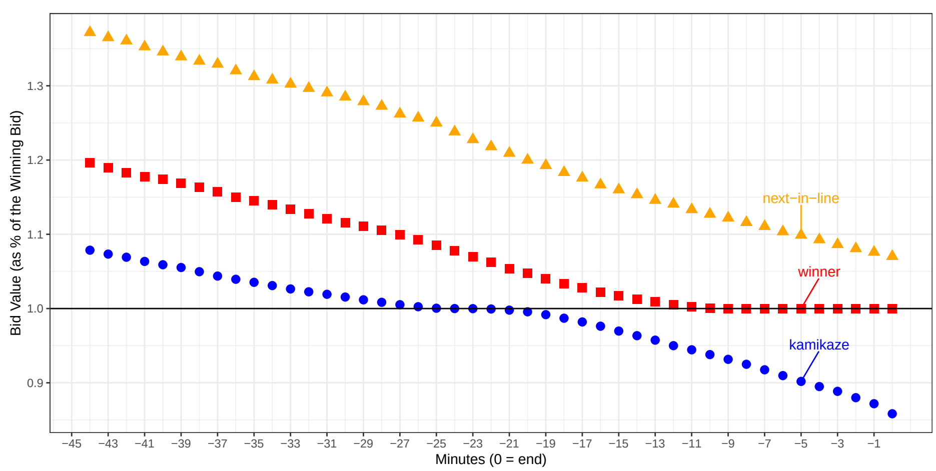
This table examines how coordination between kamikaze firms and winners affects real outcomes from procurement auctions. The analysis combines specifications from Tables 8 and 9, comparing outcomes between road repair and essential medicine contracts awarded via kamikaze versus non-kamikaze auctions, differentiated by connection status between the kamikaze firm and the winning firm. Kamikaze auctions are defined as those in which a kamikaze firm participated—firms that submit the lowest bid but do not win the procurement because they fail to satisfy the final formalities required to be declared the winner. Connected$_{ie}$ equals 1 if the kamikaze firm and winning firm share the same owner, have the same registered address, or have formed repeated partnerships in other auctions within the past 12 months, as detailed in Table 2. Unconnected$_{ie}$ equals 1 for kamikaze auctions where no such relationships exist. For road outcomes, we compare road repairs awarded through kamikaze auctions to road repairs awarded through non-kamikaze auctions in the same quarter. For hospital outcomes, we use the hospital-cause-cohort treatment definition described in Table 9. We then stack these observations in a stacked difference-in-differences design. For road accidents (columns I-II), the dependent variables are the logarithm of road-fault accidents and victims, respectively. For hospital mortality (columns III-IV), the dependent variable is the ratio between deaths and number of inpatients in hospital i, cohort e, and year t for all causes. Columns III and IV use 2-year and 3-year windows around each cohort, respectively. Road regressions control for Cohort-Road and Road Extension-Cohort-Year fixed effects, where Road Extension refers to quintiles based on road length. Hospital regressions control for Hospital-Cohort-Cause, Cause-Cohort-Year, and Hospital-Cohort-Year fixed effects. Standard errors clustered at the cohort level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Figure 1: *Evolution of Kamikaze Bidding in Public Procurement Auctions*



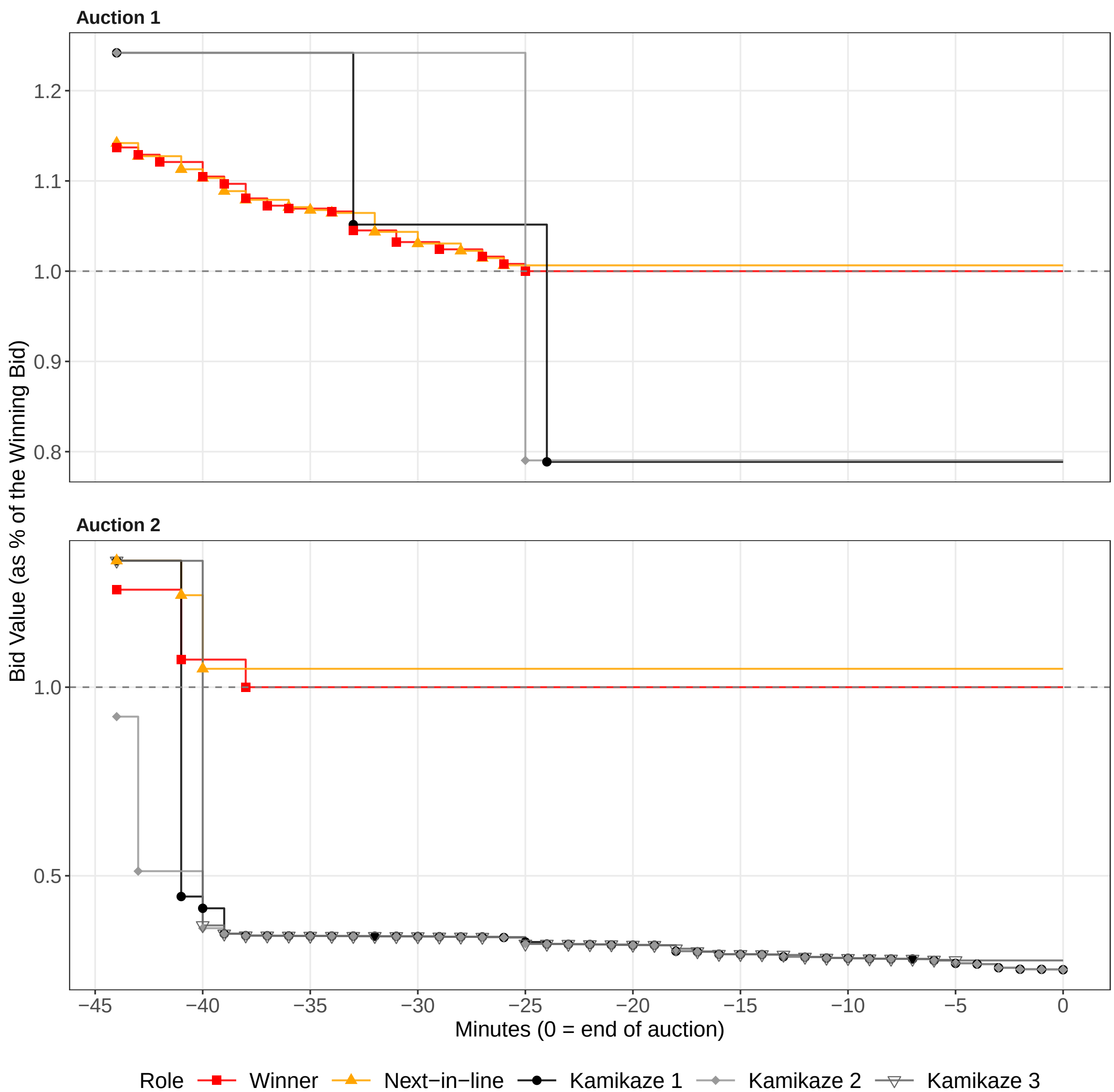
This figure shows the average fraction of auctions with kamikazes in Brazil between 2007 and 2021. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner by, for instance, withdrawing, not submitting the required documents, or providing inadequate documentation.

Figure 2: *Bid Dynamics for Kamikaze, Winner, and Next in Line Bidders: Median Across All Auctions*



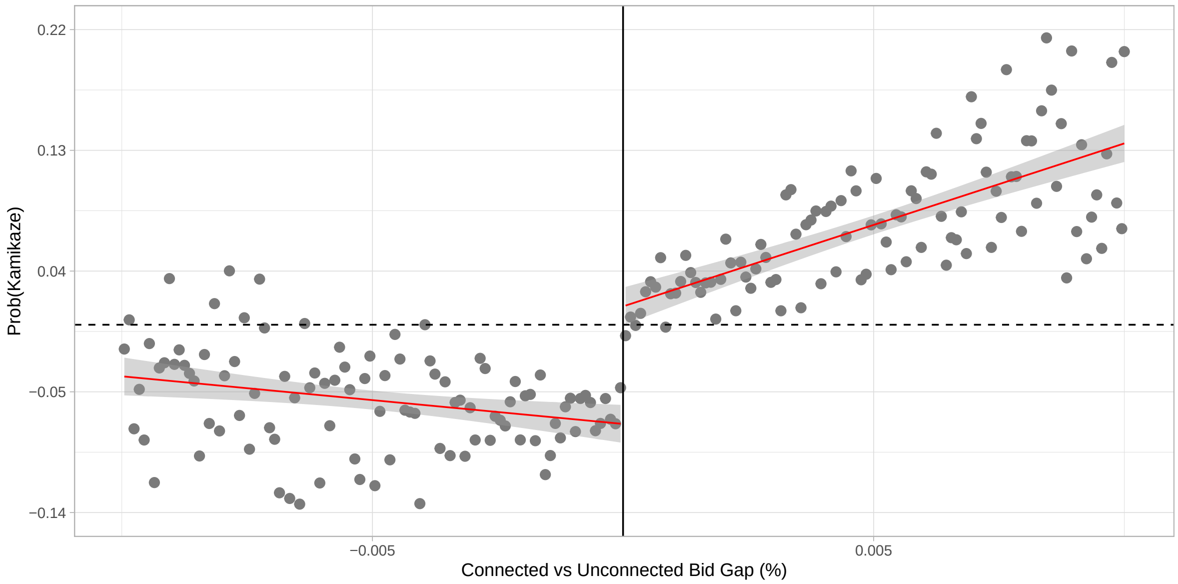
This figure plots the dynamic development of the median bid price in the minutes leading up to the end of the auction for three types of bidders: kamikaze participants (blue circles), eventual winning bidders (red squares), and next-in-line bidders (orange triangles). The bid prices are expressed as a percentage of the winning bid. To construct this plot, we first gather the bids for each auction and each minute before the end. If a bidder does not make a new bid within a given minute, we carry forward the value of their bid from the previous minute. We then plot the median bids for each type of bidder.

Figure 3: *Bid Dynamics for Kamikaze, Winner, and Next in Line Bidders: Two Particular Auctions*



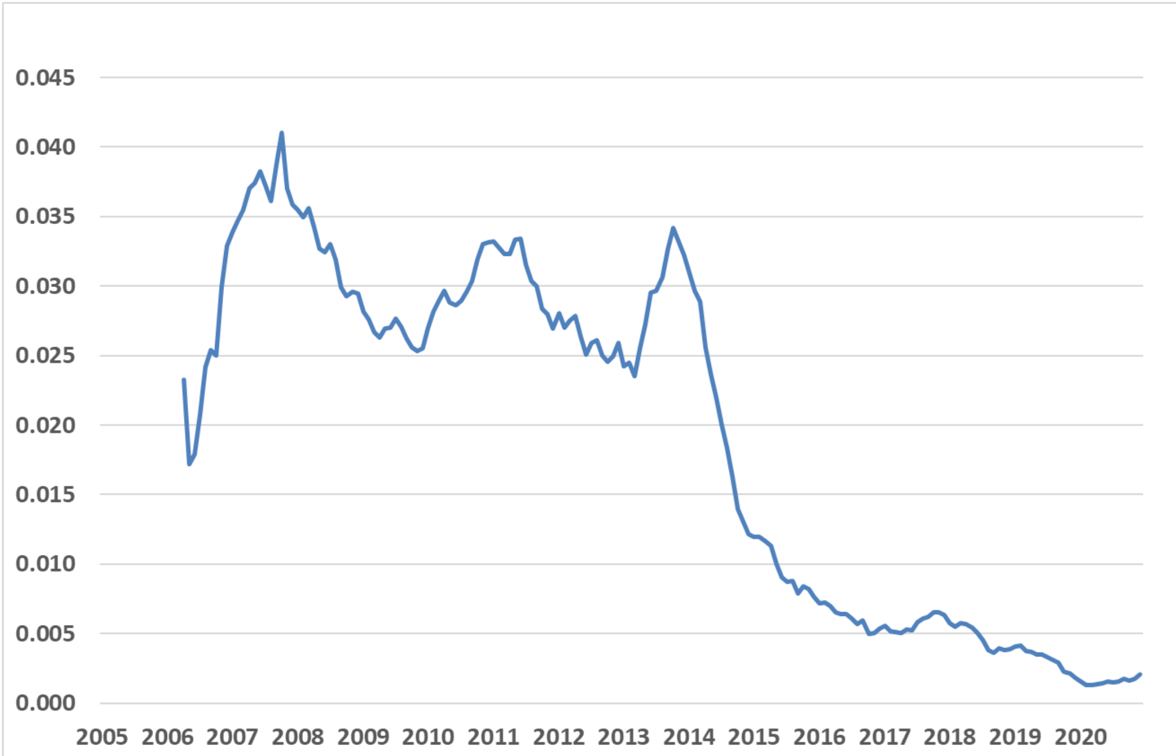
This figure plots the dynamic development of the bid price in the minutes leading up to the end of the auction for three types of bidders: kamikaze participants (black and gray circles), eventual winning bidders (red squares), and next-in-line bidders (orange triangles), for two selected auctions. The bid prices are expressed as a percentage of the winning bid. To construct this plot, we first gather the bids for each auction and each minute before the end. If a bidder does not make a new bid within a given minute, we carry forward the value of their bid from the previous minute. We then plot the bids for each type of bidder, with each auction shown in a separate panel.

Figure 4: *Regression Discontinuity Evidence of Strategic Coordination*



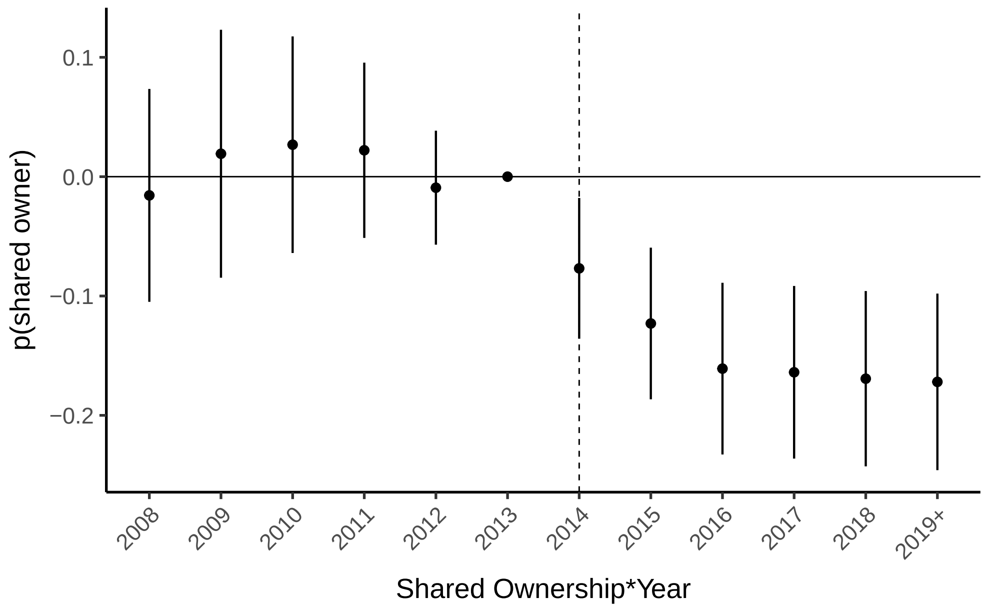
This figure presents regression discontinuity plots examining whether kamikaze firms are more likely to withdraw when connected firms would benefit from the withdrawal. The horizontal axis shows the normalized bid difference between connected and unconnected firms competing for second place: (Connected firm's bid - Unconnected firm's bid). Positive values indicate that connected firms have lower bids (are in second place), while negative values indicate unconnected firms have lower bids. The vertical axis shows the kamikaze withdrawal rate. The vertical line at zero represents the threshold where connected and unconnected firms are essentially tied for second place. The fitted lines on either side of the threshold show the local linear regression estimates, and the confidence intervals are displayed in gray.

Figure 5: *Proportion of Procurements with Shared Owners*



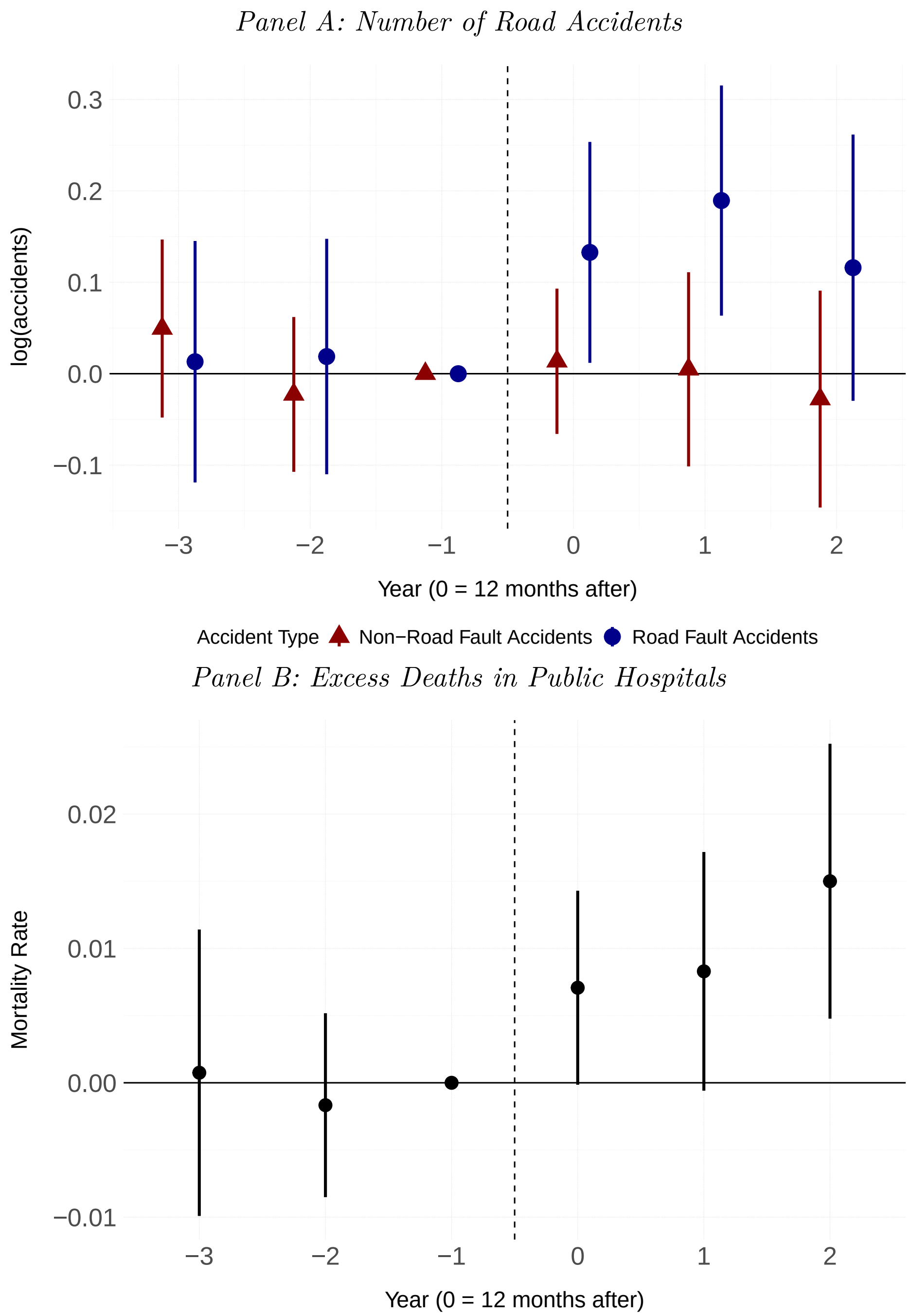
This figure plots the proportion of the procurement with shared owner participants over time.

Figure 6: The Effect of the Transparency Reform on Use of Shared Ownership



This figure plots the dynamic (event-study) effects of the 2014 introduction of the shared-ownership alert in the ComprasNet system on the probability that a firm participates in a procurement in which it shares ownership with another participant. Each point is the coefficient on the interaction of Shared Ownership$_j$ with a year indicator. 2013 is the omitted reference year. Shared Ownership$_j$ is the value-weighted fraction of kamikaze auctions won by firm j before 2014 in which it also shared ownership with the kamikaze firm. All regressions include firm and year fixed effects, with standard errors clustered at the firm level; vertical bars are 95% confidence intervals.

Figure 7: *Excess Deaths in Public Hospitals and Number of Road Accidents*



This figure plots the dynamic effects of kamikaze versus non-kamikaze auctions, along with the corresponding 95% confidence intervals. Panel A shows the effects on the number of road accidents due to road fault conditions (blue circles) and non-road fault accidents (red triangles) for road repair contracts, while Panel B shows the effects on hospital mortality rates for essential medicine purchases. In both panels, the x-axis denotes the year relative to event 0 (the 12 months after the occurrence of kamikaze). The y-axis indicates changes in the number of accidents (Panel A) and in mortality rates (Panel B).

Internet Appendix

Kamikazes and Public Procurements
Bid-Rigging and Real Non-Market Outcomes

For Online Publication Only

A Additional Tables and Figures

Table A1: *Examples of Products, Services and Government Agencies*

Panel A: Examples of Products and Services	
Description	Unit
Ballpoint Pen	1 unit
Flexible Eletric Cable	1 meter
Battery	1 unit
Ethyl Alcohol	1 liter
Coffee	500 grams
External HD	1 unit
Sugar	1 kilogram
Mineral Water	20 liters
Detergent	500 mililiters
HP Printer Toner Cartridge	1 unit
White Board Pen	1 unit
Insulin	3 mililiters
Microscope	1 unit
Petrol	1 liter
Security Services	1 month
Landline	1 minute

Panel B: Government Agencies	
Name of Government Agency	Classification
Universidade Federal do Rio Grande do Sul	Education
Universidade Federal do Pará	Education
Universidade Federal de Pernambuco	Education
Hospital Universitario UFSC	Hospitals
Hospital Universitario Antonio Pedro (UFF/RJ)	Hospitals
Hospital Universitario Gaffree e Guinele (UNIRIO)	Hospitals
Grupamento de Apoio de São José dos Campos	Armed Forces
Grupamento de Apoio de Brasilia	Armed Forces
14 Grupo de Artilharia de Campanha	Armed Forces
Comissao Nacional de Energia Nuclear	Other
Governo do Estado do Ceara	Other
Departamento de Logistica em Saude	Other

Panel A shows examples of products and services from CADMAT and CADSER, while Panel B provides examples of government institutions in the procurement dataset.

Table A2: *Relationships between Kamikaze Firms and Winners: Firm-by-Year Fixed Effects*

	$p(\text{winner})_{ipj}$				
	I	II	III	IV	V
Same Owners$_{ipj}$	0.0680**				0.0447*
	(0.0207)				(0.0203)
Same Address$_{ipj}$		0.0559***			0.0361***
		(0.0103)			(0.0102)
Repeat Partnership$_{ipj}$			0.1238***	0.1261***	0.1260***
			(0.0014)	(0.0014)	(0.0014)
Repeat Win With Kami$_{ipj}$				-0.0529***	-0.0529***
				(0.0026)	(0.0026)
Repeat Win$_{ipj}$				0.0279***	0.0279***
				(0.0032)	(0.0032)
Obs	19,083,454	19,083,454	19,080,793	19,080,793	19,080,793
R^2	0.278	0.278	0.293	0.293	0.293
Procurement × Item FEs	Yes	Yes	Yes	Yes	Yes
Firm × Year FEs	Yes	Yes	Yes	Yes	Yes

This table reports the same specification as Table 2, adding Firm-by-Year fixed effects to absorb time-varying firm-level shocks (e.g., changes in firm size, productivity, or market position). The specification is

$$y_{ipj} = \alpha_{ip} + \alpha_{jt} + \beta \cdot X_{ipj} + e_{ipj}$$

where y_{ipj} is $p(\text{winner})_{ipj}$, a dummy equal to 1 if bidder j at procurement i for item p is the winner. Column I includes Same Owners$_{ipj}$, column II Same Address$_{ipj}$, column III Repeat Partnership$_{ipj}$, column IV adds Repeat Win With Kami$_{ipj}$ and Repeat Win$_{ipj}$, and column V includes all simultaneously. All columns control for Procurement-by-Item (α_{ip}) and Firm-by-Year (α_{jt}) fixed effects. The sample includes all participating firms except the kamikaze firms themselves. Standard errors clustered at the firm level are in parentheses. $^+$, *, **, and *** denote significance at 10%, 5%, 1%, and 0.1% levels, respectively.

Table A3: *Kamikaze Firms and Procurement Outcomes: Market Composition Controls*

	$\log(\text{price})_{ipt}$			
	I	II	III	IV
Has Kamikaze$_{ipt}$	0.0876***	0.1008***	0.0883***	0.1008***
	(0.0040)	(0.0045)	(0.0039)	(0.0045)
log(Avg. Age Bidders)$_{ipt}$			0.0363*	0.0375**
			(0.0143)	(0.0137)
log(Avg. Size Bidders)$_{ipt}$			−0.0023	0.0022
			(0.0197)	(0.0193)
Obs	14,967,462	14,967,462	14,967,377	14,967,377
R^2	0.871	0.871	0.871	0.871
Item × Year FEs	Yes	Yes	Yes	Yes
Gov Institution × Year FEs	Yes	Yes	Yes	Yes
# Incumbents × # Genuine × Year FEs	Yes		Yes	
# Past Non-Kami. Winners × # Genuine × Year FEs		Yes		Yes

This table extends Table 5 with market-composition controls among genuine bidders. All columns include Item-Year and Gov Institution-Year fixed effects. Column I adds # Incumbents-# Genuine-Year fixed effects and column II adds # Past Non-Kamikaze Winners-# Genuine-Year fixed effects, in each case comparing kamikaze and non-kamikaze auctions with the same competitive composition. Columns III and IV repeat columns I and II, respectively, additionally controlling for the logarithm of the average age and size of the genuine bidders. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table A4: *Products/Services by Prevalence of Kamikaze Bidding*

Description	Kamikaze Fraction
High Kamikaze Prevalence	
Government Administrative Services	0.601
Personnel Services	0.511
Engineering Services	0.503
General Cleaning Services	0.495
Printer Toner Cartridge	0.494
Office Workstation/Partitions	0.440
Notebook Computer	0.435
Cleaning Services	0.429
IT Support Services	0.427
Led Lamp	0.315
Low Kamikaze Prevalence	
Tool Parts	0.110
Construction Stone	0.118
Gas (Fuel)	0.089
Insurance Services	0.077
Veterinary Equipment	0.075
Glass Fuse	0.068
Compressed Gas	0.064
Landline Services	0.049
Books	0.052
Technical Publications	0.014

This table shows examples of products and services across the spectrum of kamikaze bidding prevalence. Kamikaze Fraction represents the proportion of auctions for each product/service that featured kamikaze bidders.

Table A5: *Organizations by Prevalence of Kamikaze Bidding*

Organization	Kamikaze Fraction
High Kamikaze Prevalence	
Base Aérea de Brasília/DF (Maer-Babr)	0.633
Superintendência de Administração em São Paulo	0.537
Estação Naval do Rio Negro	0.502
Base de Apoio Logístico do Exército	0.490
Fundação de Atendimento Socioeducativo do Pará	0.490
Departamento de Educação e Cultura do Exército	0.475
Batalhão de Suprimento (Mex-9)/MS	0.468
3° Centro Integrado de Defesa Aérea e Controle de Tráfego Aéreo	0.467
Gerência Regional em São Paulo	0.456
Base Aérea dos Afonsos	0.448
Lowest Kamikaze Prevalence	
Biblioteca Central da UFPB	0.022
3° Regimento de Carros de Combate	0.031
Centro Federal de Educação Tecnológica de Urutaí	0.035
CEFET/BA	0.035
Faculdade de Filosofia e Ciências Humanas/UFMG	0.036
Instituto Federal de Rondônia/Campus Ariquemes	0.041
22° Grupo de Artilharia de Campanha/RS	0.047
5ª Brigada de Cavalaria Blindada	0.048
Fundação Diamantinense de Apoio ao Ensino e Pesquisa	0.050
Hospital da Guarnição de Alegrete/RS	0.050

This table shows examples of organizations across the spectrum of kamikaze bidding prevalence. Kamikaze Fraction represents the proportion of auctions for each organization that featured kamikaze bidders.

Table A6: *Heterogeneous Effects*

	$\log(\text{price})_{ipt}$				
	I	II	III	IV	V
Has Kamikaze$_{ipt}$	0.1669***	0.1423***	0.1667***	0.1039***	0.1262***
	(0.0060)	(0.0060)	(0.0057)	(0.0139)	(0.0105)
Has Kamikaze$_{ipt}$ · High Kamikaze$_a$	-0.0009				
	(0.0054)				
Has Kamikaze$_{ipt}$ · High Kamikaze$_p$		0.0319***			
		(0.0074)			
Has Kamikaze$_{ipt}$ · Local$_a$			-0.0028		
			(0.0089)		
Has Kamikaze$_{ipt}$ · Product$_p$				0.0700***	
				(0.0142)	
Has Kamikaze$_{ipt}$ · High # Sim. Auct.$_{it}$					0.0425***
					(0.0088)
Obs	14,967,462	14,967,462	14,967,462	14,967,462	13,574,911
R^2	0.870	0.870	0.870	0.870	0.872
Item × Year FEs	Yes	Yes	Yes	Yes	Yes
# Genuine Bidders × Year FEs	Yes	Yes	Yes	Yes	Yes
Gov Institution × Year FEs	Yes	Yes	Yes	Yes	Yes

This table examines how the heterogeneous effects of kamikaze firms on procurement outcomes vary across institutions, items, and auction characteristics. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. The dependent variable y_{ipt} is the logarithm of the price for item p purchased in procurement i at time t. Has Kamikaze$_{ipt}$ is equal to 1 if procurement i for item p at time t has a kamikaze firm and 0, otherwise. In column I, High Kamikaze$_a$ equals 1 if government institution a is in the upper median in the incidence of kamikaze auctions and 0, otherwise. In column II, High Kamikaze$_p$ equals 1 if item p is in the upper median in the incidence of kamikaze auctions and 0, otherwise. In column III, Local$_a$ equals 1 if the government institution a is either a municipality or state government agency and 0, otherwise. In column IV, Product$_p$ equals 1 for products and 0 for services. In column V, High # Sim. Auct.$_{it}$ is a dummy equal to 1 if procurement i has an above-median number of simultaneous auctions and 0 otherwise. All specifications control for Item-by-Year, Government Institution-by-Year, and # Genuine Bidders-by-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. See caption of Table 5 for further details of the specifications.

Table A7: *Kamikaze Firms and Procurement Outcomes: Controlling for the Same Kamikaze Firm*

	$\log(\text{price})_{ipjt}$		
	I	II	III
Is Kamikaze$_{ipt}$	0.1545***	0.1306***	0.1034***
	(0.0072)	(0.0058)	(0.0124)
Obs	10,918,266	10,918,266	10,918,266
R^2	0.911	0.914	0.939
Firm × Item × Year FEs	Yes	Yes	
# Genuine Bidders × Year FEs	Yes	Yes	Yes
Gov Institution × Year FEs		Yes	
Firm × Gov Institution × Item × Year FEs			Yes

This table compares outcomes of procurement auctions with and without the presence of kamikaze firms. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. The analysis compares auctions where the same firm submits the lowest bid but has different outcomes: either the same firm withdraws (kamikaze behavior, Is Kamikaze = 1) or the firm successfully completes the formalities and wins the contract (Is Kamikaze = 0). The dependent variable is the logarithm of the price for item p purchased in procurement i where firm j participated at time t. Is Kamikaze$_{ipt}$ is equal to 1 if procurement i for item p at time t has a kamikaze firm and 0, otherwise. The sample includes all auctions where a firm submitted the lowest bid, restricting to firms that acted as kamikaze (withdrew after winning) at least once for the same item-year combination. In columns I to III, we progressively add fixed effects. Column I includes Kamikaze Firm-by-Item-by-Year fixed effects (comparing auctions with the same lowest-bidding firm for the same item and year) and # Genuine Bidders-by-Year fixed effects comparing procurements with the same number of genuine participants and year. Column II adds Government Institution-by-Year fixed effects. Column III includes Kamikaze Firm-Government Institution-Item-Year fixed effects while maintaining # Genuine Bidders-by-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. See caption of Table 5 for further details of the specifications.

Table A8: *Kamikaze Firms and Competitive Intensity*

	# bids per bidder$_{ipt}$		$\sigma(bid)/\overline{bid}_{ipt}$	
	I	II	III	IV
Has Kamikaze$_{ipt}$	−1.075***	−0.8540***	−0.0531***	−0.0347***
	(0.0217)	(0.0152)	(0.0033)	(0.0024)
Obs	14,967,403	14,967,403	14,967,403	14,967,403
R^2	0.178	0.227	0.366	0.431
Item × Year FEs	Yes	Yes	Yes	Yes
# Genuine Bidders × Year FEs	Yes	Yes	Yes	Yes
Gov Institution × Year FEs		Yes		Yes

This table examines how the presence of kamikaze firms affects the competitive intensity of bidding. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. The dependent variable is the average number of bids per bidder of procurement i for item p at time t (columns I and II) or the ratio of the standard deviation of the bid value to the average bid value (columns III and IV). # bids per bidder$_{ipt}$ and $\sigma(bid)/\overline{bid}_{ipt}$ are constructed by only considering bids of non-kamikaze firms. Has Kamikaze$_{ipt}$ equals 1 if procurement i for item p at time t has a kamikaze firm and 0, otherwise. Columns I and III control for Item-by-Year and # Genuine Bidders-by-Year fixed effects; columns II and IV also include Government Institution-by-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. See caption of Table 5 for further details of the specifications.

Table A9: *Kamikaze Firms and Difference Between Winning and Next-in-Line Bids*

	Winning Bid - Next-In-Line Bid$_{ipt}$ (as a % of winning bid)	
	I	II
Has Kamikaze$_{ipt}$	0.1987***	0.2011***
	(0.0036)	(0.0034)
Obs	13,540,521	13,540,521
R^2	0.161	0.186
Item × Year FEs	Yes	Yes
# Genuine Bidders × Year FEs	Yes	Yes
Gov Institution × Year FEs		Yes

This table examines how kamikaze firms affect the gap between winning and next-in-line bids in procurement auctions. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. The dependent variable is the difference between the eventually winning bid and the next bid as a percentage of the winning bid. Has Kamikaze$_{ipt}$ is equal to 1 if procurement i for item p at time t has a kamikaze firm and 0, otherwise. Column I controls for Item-by-Year and # Genuine Bidders-by-Year fixed effects. Column II also includes Government Institution-by-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. Other than a different dependent variable, specification is the same as in Table 5. See caption of Table 5 for further details of the specifications.

Table A10: *Road-Related and Non-Road-Related Accident Causes*

Road-Related Causes	Non-Road-Related Causes
Slippery road	Lack of attention
Water accumulation on pavement	Not maintaining safe distance
Oil accumulation on pavement	Incompatible speed
Potholed road	Improper overtaking
Sand or debris on pavement	Disobeying traffic signs
Uneven road surfaces	Sleeping/drowsy driving
Depressions or undulations in pavement	Alcohol ingestion
Road in disrepair	Use of psychoactive substances
Sharp curves	Using mobile phone while driving
Steep slopes	Failure to react or inefficient reaction
Insufficient lane width	Abrupt braking
Uneven shoulder	Disregarding right of way at intersections
Lack of shoulder	Driving in the wrong direction
Temporary detours	Changing lanes improperly
Irregular access	Prohibited turns or returns
Road in different levels	Accessing road without observing other vehicles
Limited visibility at horizontal curves	Parking or stopping in prohibited locations
Limited visibility at vertical curves	Driving on the sidewalk
Reduced visibility (general)	Driving on the shoulder
Insufficient or inadequate road signaling	Participating in street racing
Absence of signaling	Motorcycling between lanes
Poorly positioned signaling	Disregarding red traffic light
Covered signaling	Pedestrian inattention
Defective traffic light	Pedestrian improper use of the road
Lack of containment elements	Sudden pedestrian entry
Urban area without pedestrian crossing	Pedestrian disobeying traffic rules
Static object on the roadway	Alcohol/substance use by pedestrian
Works on the road	Mechanical or electrical failures
Roadway obstruction	Tire damage or excessive wear
Animals on the road	Brake/Suspension problems
Inefficient drainage system	Vehicle mechanical defects
Non-compliant speed reducer	Modified vehicle (prohibited modifications)
Poor lighting	Misaligned headlights
	Deficiency in vehicle lighting/signaling systems
	Excessive and/or poorly conditioned load
	Driver sudden illness
	External aggression
	Environmental factors
	Other unspecified causes

This table categorizes accident causes from the Federal Highway Patrol dataset into road-related and non-road-related factors.

Table A11: *DataSUS: International Classification of Diseases*

Certain infectious and parasitic diseases
Neoplasms
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism
Endocrine, nutritional and metabolic diseases
Mental and behavioural disorders
Diseases of the nervous system
Diseases of the eye and adnexa
Diseases of the ear and mastoid process
Diseases of the circulatory system
Diseases of the respiratory system
Diseases of the digestive system
Diseases of the skin and subcutaneous tissue
Diseases of the musculoskeletal system and connective tissue
Diseases of the genitourinary system
Pregnancy, childbirth and the puerperium
Certain conditions originating in the perinatal period
Congenital malformations, deformations and chromosomal abnormalities
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified
Injury, poisoning and certain other consequences of external causes
External causes of morbidity and mortality
Factors influencing health status and contact with health services
Codes for special purposes

This table lists the different disease classifications from the World Health Organization's International Classification of Diseases. These categories correspond to how DataSUS records diseases in their hospital mortality dataset.

Table A12: *Kamikaze Auctions on Contract Quality: Hospital Sample*

	p(canceled)$_{ijt}$	p(cost overrun)$_{ijt}$	p(under-delivered)$_{ijt}$	log(days)$_{ijt}$
	I	II	III	IV
Has Kamikaze$_{ijt}$	0.0475***	0.0114**	0.0604***	0.0574***
	(0.0064)	(0.0036)	(0.0073)	(0.0125)
Obs	26,899	26,899	26,899	26,508
R^2	0.182	0.337	0.096	0.217
Institution × Year FEs	Yes	Yes	Yes	Yes

This table reports the effect of kamikaze bidding on contract-quality outcomes restricted to the hospital sample. We estimate:

$$y_{ijt} = \alpha_{at} + \beta \cdot \text{Has Kamikaze}_{ijt} + e_{ijt},$$

where y_{ijt} are outcomes for procurement i with winner firm j at time t in the hospital sample. The outcomes are: the probability that the contract is canceled (column I); the probability that the contract experiences a cost overrun, measured as whether additional funds are committed beyond the original contract value (column II); the probability that the contract is under-delivered, measured as whether the confirmed delivery value is strictly below the committed contract value (column III); and the logarithm of days from contract commitment to the last delivery confirmation (column IV). All specifications include institution-by-year fixed effects (α_{at}), comparing outcomes across procurements within the same hospital and year. Standard errors clustered at the government institution (*uasg*) level are in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table A13: Falsification Tests: Non-Essential Procurement and Wrong Disease Assignment

	mortality rate_{iet}			
	Non-Essential		Wrong Disease	
	I	II	III	IV
Kamikaze $\text{Auction}_{ie} \cdot \text{Post}_{et}$	0.0014	0.0024	−0.0013	−0.0003
	(0.0015)	(0.0016)	(0.0011)	(0.0010)
Window	2y	3y	2y	3y
Obs	113,380	165,014	78,311	115,686
R^2	0.836	0.809	0.979	0.974
Hospital × Cohort × Cause	Yes	Yes	Yes	Yes
Cause × Cohort × Year	Yes	Yes	Yes	Yes

This table presents two falsification tests for the hospital mortality results. In columns I-II, we replicate the main mortality specification but replace essential medicine kamikaze exposure with kamikaze exposure in non-essential procurement categories (265 product codes with no clinical pathway, including office supplies, IT equipment, construction materials, vehicles, and furniture). If the mortality effect operates through hospital-wide budget depletion, non-essential kamikaze should also affect mortality. The null coefficients indicate that only drug-disease-specific procurement disruption matters. In columns III-IV, we assign each essential medicine to diseases it does *not* treat (e.g., a cardiovascular drug is assigned to respiratory disease mortality). If the effect is drug-disease-specific, this misassignment should produce null effects. The coefficients are insignificant and opposite in sign to the main effect (+0.008***), confirming drug-disease specificity.
Both panels exclude staggered cohorts to avoid bias from already-treated controls in the stacked difference-in-differences design. We estimate:

$$y_{iet} = \alpha_{ie} + \alpha_{et} + \beta \cdot \text{Kamikaze Auction}_{ie} \cdot \text{Post}_{et} + u_{iet}$$

where y_{iet} is the mortality rate in hospital i, cohort e, and year t. In columns I-II, Kamikaze Auction_{ie} equals 1 if at least 90% of the hospital's non-essential procurement purchases in the cohort quarter were awarded in kamikaze auctions. In columns III-IV, Kamikaze Auction_{ie} equals 1 if essential medicines for an *unrelated* disease were purchased in kamikaze auctions. Standard errors clustered at the cohort level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table A14: *Kamikaze Firms and Procurement Outcomes: Effects by Kamikaze Intensity*

	$\log(\text{price})_{ipt}$	
	I	II
1 Kamikaze Firm_{ipt}	0.0653***	0.0525***
	(0.0034)	(0.0030)
2 Kamikaze Firms_{ipt}	0.1389***	0.1188***
	(0.0062)	(0.0051)
3 Kamikaze Firms_{ipt}	0.1982***	0.1756***
	(0.0093)	(0.0071)
4 Kamikaze Firms_{ipt}	0.2597***	0.2245***
	(0.0115)	(0.0101)
5+ Kamikaze Firms_{ipt}	0.3566***	0.3247***
	(0.0180)	(0.0154)
Obs	14,967,462	14,967,462
R^2	0.865	0.870
Item × Year FEs	Yes	Yes
# of Genuine Bidders × Year FEs	Yes	Yes
Gov Institution × Year FEs		Yes

This table extends the analysis of procurement auctions with and without the presence of kamikaze firms presented in Table 5 and focuses on how the effect of kamikaze firms on pricing varies with the number of kamikaze firms. Kamikaze firms are defined as those firms that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. The main independent variables are indicators based on the number of kamikaze firms in procurement i for item p at year t, i.e., 1, 2, 3, 4, or 5+ kamikaze firms. The dependent variable is the logarithm of the price for item p purchased in procurement i at time t. Column I controls for Item-by-Year and # of Genuine Bidders-by-Year fixed effects. Column II also includes Government Institution-by-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. See caption of Table 5 for further details of the specifications.

Table A15: *Characteristics of Kamikaze Firms*

	p(kamikaze)$_{ipj}$		p(winner)$_{ipj}$	
	I	II	III	IV
Young Firm$_{ipj}$	0.0324***		-0.0168***	
	(0.0031)		(0.0015)	
Small Firm$_{ipj}$		0.0389***		-0.0532***
		(0.0046)		(0.0033)
Obs	24,989,145	24,989,145	24,989,830	24,989,830
R^2	0.176	0.175	0.086	0.088
Procurement × Item FEs	Yes	Yes	Yes	Yes

This table shows the characteristics of kamikaze and winning firms. Kamikaze firms are those that have the lowest bid but do not win the procurement because they do not satisfy the final formalities required to be declared the winner. This table follows the same specification as in Table 2, but with different dependent and independent variables. The dependent variables are p(kamikaze)$_{ipj}$ — a dummy equal to 1 if bidder j at procurement i for item p is a kamikaze firm and zero otherwise — in columns I and II, and p(winner)$_{ipj}$ — a dummy equal to 1 if bidder j at procurement i for item p is the winner and zero otherwise in columns III to IV. The independent variables are the probability that firm j was created less than 3 years ago (columns I and III), and the probability that firm j is small, as defined by the official government classification (columns II and IV). All columns control for Procurement-by-Item fixed effects. Standard errors clustered at the firm level are presented in parentheses. $^{+}$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table A16: *Switching Across Procurements*

	p(kamikaze)$_{ipjt}$		p(winner)$_{ipjt}$		
	I	II	III	IV	V
Was Kamikaze$_{j,t-1:t-12}$	0.0028***		-0.0108***		
	(0.0005)		(0.0015)		
Was Winner in Kamikaze Procur$_{j,t-1:t-12}$		-0.0069***		0.0156***	0.0126***
		(0.0005)		(0.0014)	(0.0016)
Was Winner$_{j,t-1:t-12}$					0.0053***
					(0.0015)
Obs	86,165,835	86,165,835	86,169,148	86,169,148	86,169,148
R^2	0.298	0.298	0.140	0.140	0.140
Procurement × Item FEs	Yes	Yes	Yes	Yes	Yes

This table examines role persistence by testing whether firms that previously acted as kamikazes or won kamikaze auctions are more likely to repeat these roles in subsequent procurements. We estimate the following specification:

$$y_{ipjt} = \alpha_{ip} + \beta_1 \cdot X_{jt} + e_{ipjt}$$

where y_{ipjt} is the probability that firm j is a kamikaze (columns I-II) or winner (columns III-V) in procurement i for item p at time t. The key explanatory variables are: Was Kamikaze$_{j,t-1:t-12}$, a dummy equal to 1 if firm j acted as a kamikaze in any procurement within the past year; and Was Winner in Kamikaze Procur$_{j,t-1:t-12}$, a dummy equal to 1 if firm j won any procurement with kamikaze presence within the past year. Column V includes Was Winner$_{j,t-1:t-12}$, indicating whether firm j won any procurement (regardless of kamikaze presence) within the past year. All columns include Procurement-by-Item fixed effects, comparing firms within the same auction. The sample includes all participating firms. Standard errors clustered at the firm level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table A17: *Switching Within Procurements*

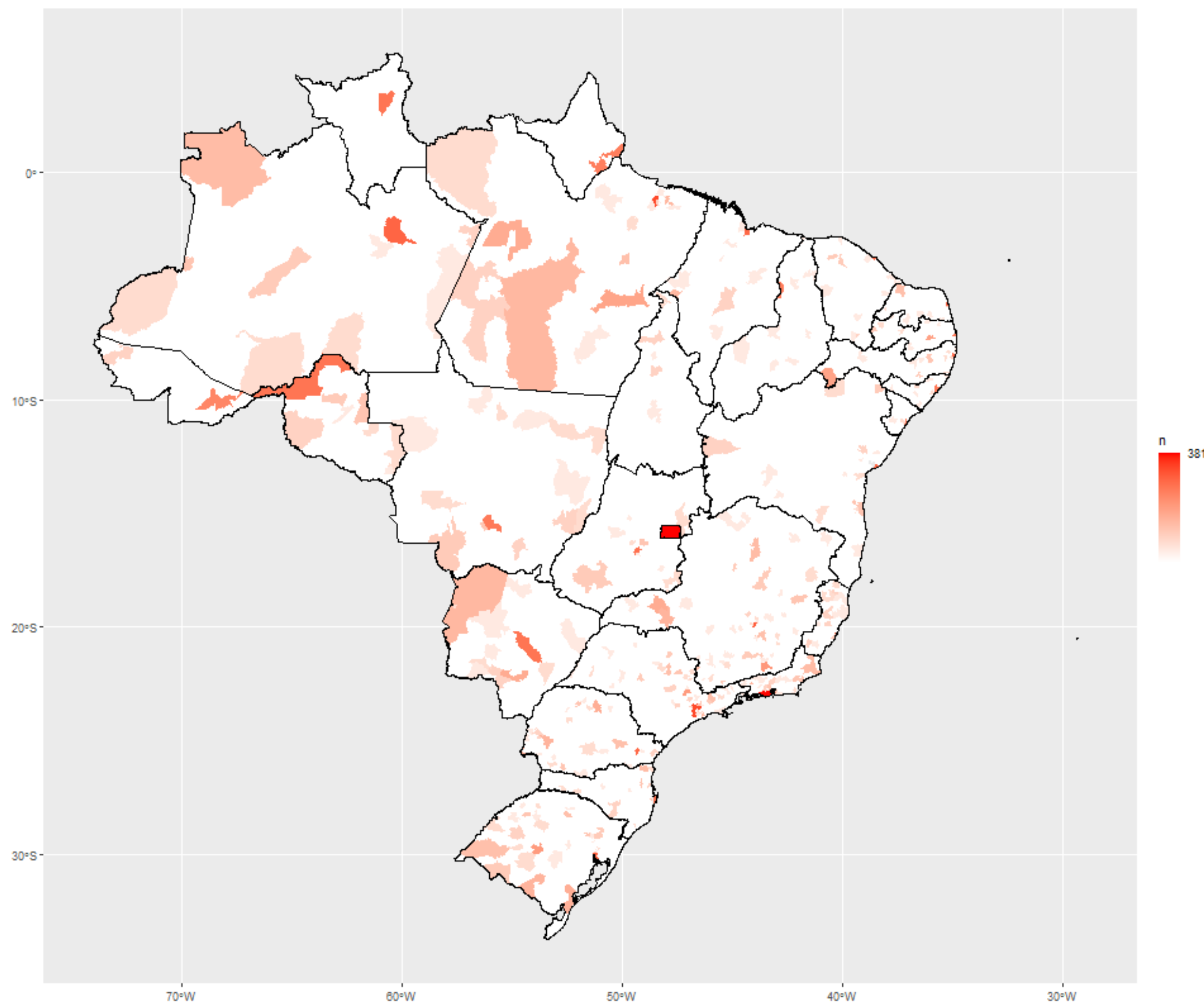
	$p(\text{kamikaze})_{ipjt}$		$p(\text{winner})_{ipjt}$		
	I	II	III	IV	V
Was Kamikaze$_{ip^*jt}$	0.0775***		-0.0240***		
	(0.0011)		(0.0013)		
Was Winner in Kamikaze Procur$_{ip^*jt}$		-0.0380***		0.1703***	0.0480***
		(0.0007)		(0.0018)	(0.0014)
Was Winner$_{ip^*jt}$					0.2135***
					(0.0019)
Obs	86,165,835	86,165,835	86,169,148	86,169,148	85,115,139
R^2	0.319	0.303	0.140	0.174	0.238
Procurement × Item FEs	Yes	Yes	Yes	Yes	Yes

This table examines role persistence by testing whether firms that acted as kamikazes or won kamikaze auctions take the same role in other auctions of the same procurement. That is, within a procurement i, we compare the probability that a firm is a kamikaze or a winner for a product p based on its participation in other auctions within the same procurement. We implement the following specification:

$$y_{ipjt} = \alpha_{ip} + \beta_1 \cdot X_{ip^*jt} + e_{ipjt}$$

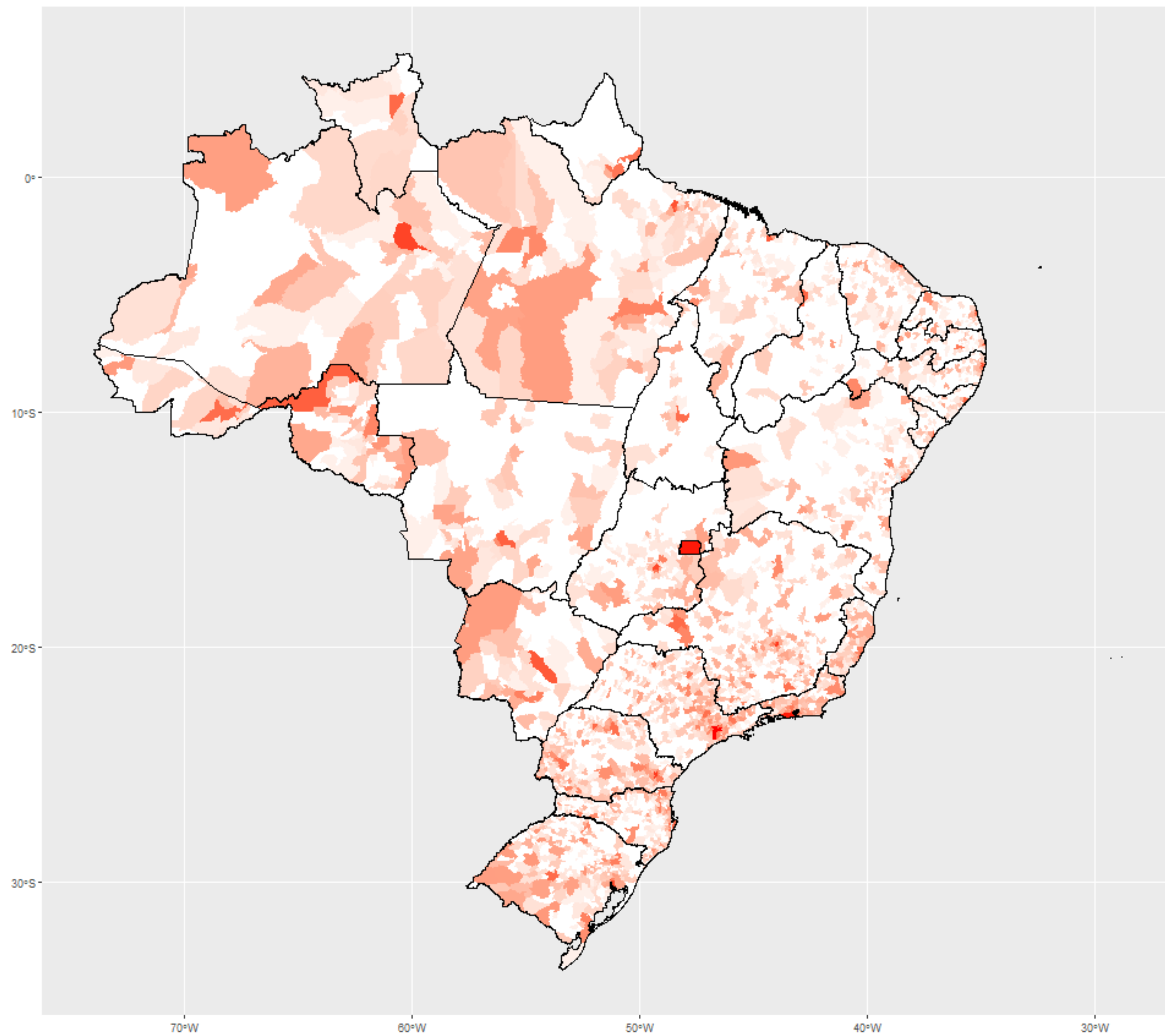
where y_{ipjt} is the probability that firm j is a kamikaze (columns I-II) or winner (columns III-V) in procurement i for item p at time t. The key explanatory variables are: Was Kamikaze$_{ip^*jt}$, a dummy equal to 1 if firm j was a Kamikaze firm in procurement i purchasing item $p^* \neq p$; and Was Winner in Kamikaze Procur$_{ip^*jt}$, a dummy equal to 1 if firm j was a winner in procurement i purchasing item $p^* \neq p$ with kamikaze presence. Column V includes Was Winner$_{ip^*jt}$, indicating whether firm j won any item $p^* \neq p$ in procurement i (regardless of kamikaze presence). All columns include Procurement-by-Item fixed effects, comparing firms within the same auction. The sample includes all participating firms. Standard errors clustered at the firm level are presented in parentheses. $^+$, *, **, and *** denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Figure A1: *Number of Government Institutions*



This figure shows the geographical distribution of the average number of government institutions from 2005 to 2021 for a sample of 1,049 municipalities with government agencies.

Figure A2: *Number of Participants*



This figure shows the geographical distribution of the average number of unique bidders from 2005 to 2021.

Figure A3: *Procurement Portal*

Panel A: Original Figure in Portuguese

COMPRASNET Electronic Bidding

UASG: 200999 - MIN. OF PLANNING BUDGET AND MANAGEMENT/DF
Auction No.: 672014
Login: fornec2

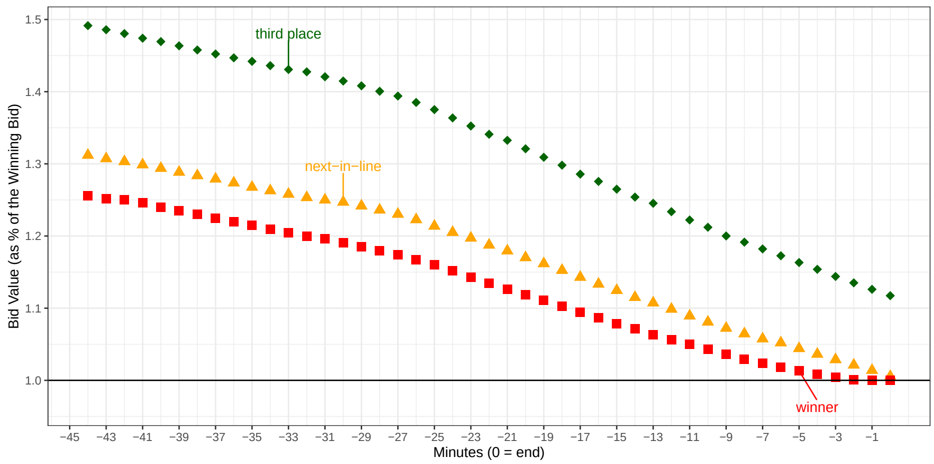
Items with Open status			**Brasilia Time: 22/05/2014 15:51**			
Item	Description	Status	Your Last Bid	Best Bid	Bid	
1	ROLLED PAPER	Impending Notice	R$ 131,345.0000	R$ 131,345.0000		Send
2	GREASE	Impending Notice	R$ 9.5400	R$ 5.1200		Send
3	SUGAR	Impending Notice	R$ 9.3400	R$ 4.9200		Send
5	ENAMEL PAINT	Impending Notice	R$ 301.5400	R$ 297.1200		Send
6	SOUND SYSTEM	Impending Notice	R$ 1,207.5400	R$ 1,203.1200		Send
4	HAIR CUTTING CAPE	Impending Notice	R$ 153,600.0000	R$ 153,600.0000		Send

• Your bid is the winner. • Your bid is NOT the winner. • Your bid is TIED.

Panel B: Corresponding English Translation

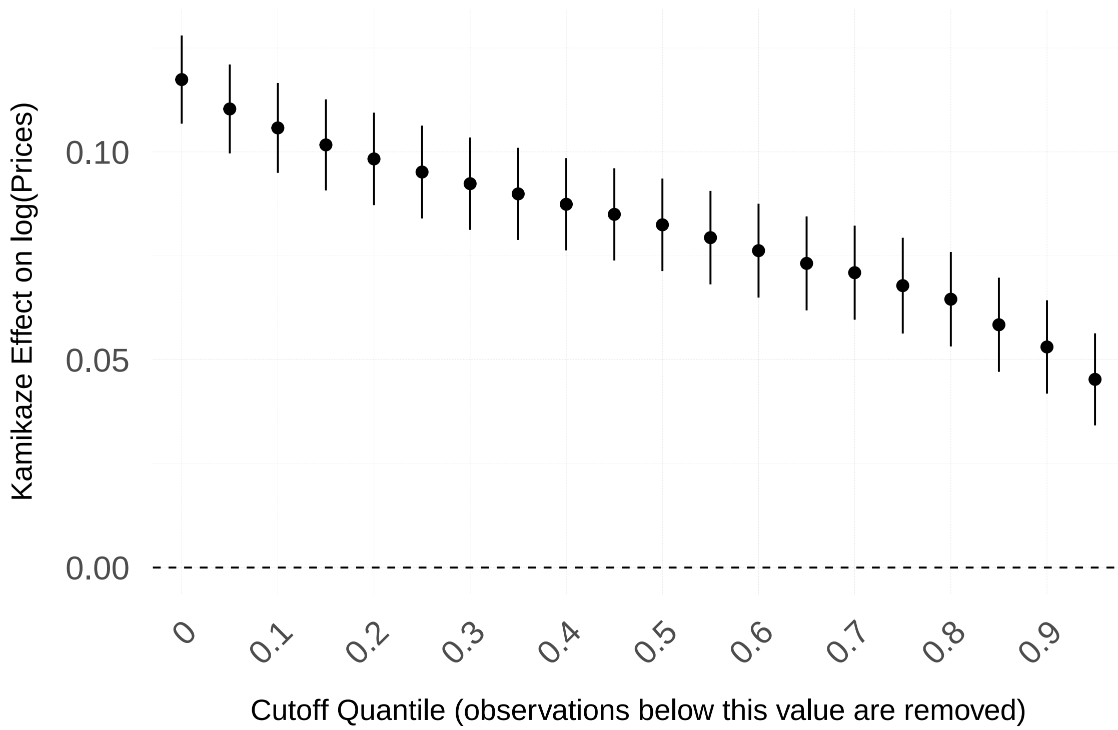
This figure plots an image of the ComprasNet portal during the procurement from the perspective of the bidder. The bidders can see information about their bid, the minimum bid, and details about the auction they participate.

Figure A4: *Bid Dynamics for Winner, Next in Line, and Third Place Bidders in Non-Kamikaze Auctions*



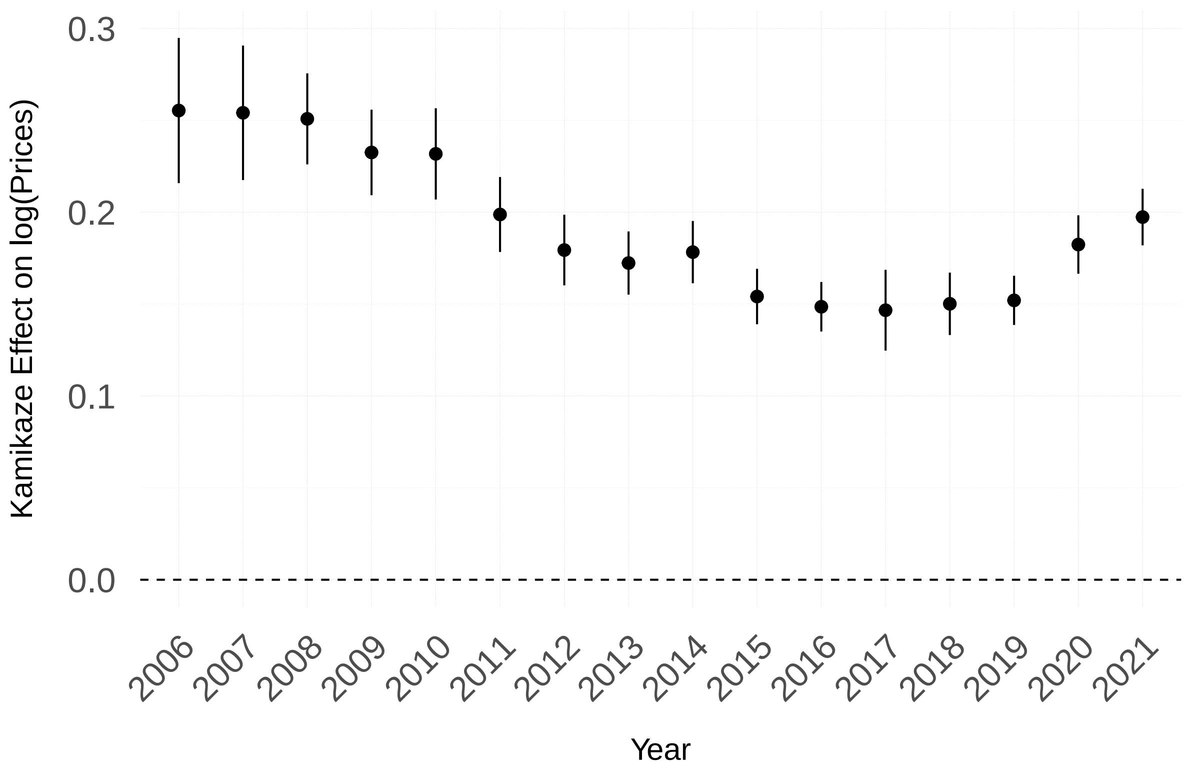
This figure plots the dynamic development of the median bid price in the minutes leading up to the end of the auction for three types of bidders: winners (red squares), next-in-line bidders (orange triangles), and third-place bidders (green diamonds). The bid prices are expressed as a percentage of the winning bid. To construct this plot, we first gather the bids for each auction and each minute before the end. If a bidder does not make a new bid within a given minute, we carry forward the value of their bid from the previous minute. We then plot the median bids for each type of bidder.

Figure A5: Effect of Kamikaze Rounds on Procurement Prices Across Value Distribution



The figure plots the estimated effect of kamikaze firms on the winning prices as reported in Table 5 as we progressively remove observations below each quantile cutoff of the procurement value distribution. For example, when the x-axis equals 0.2, all observations below the 20th percentile of contract value have been removed from the estimation. When the x-axis is zero this is the benchmark specification in Table 5, column I. The vertical lines show 95% confidence intervals with standard errors clustered at the item level.

Figure A6: *Kamikaze Firms and Overpricing Across Years*



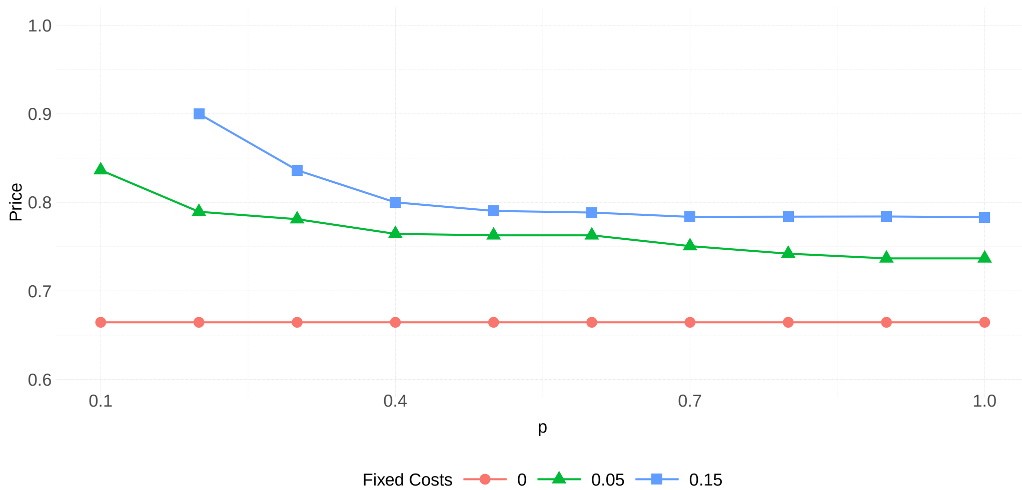
The figure plots the estimated effect of kamikaze firms on the winning prices as reported in Table 5 for different years. We estimate the baseline regression separately for each year:

$$log(price)_{ipt} = \alpha_{pt} + \alpha_{X_i,t} + \beta_t \cdot HasKamikaze_{ipt} + e_{ipt}$$

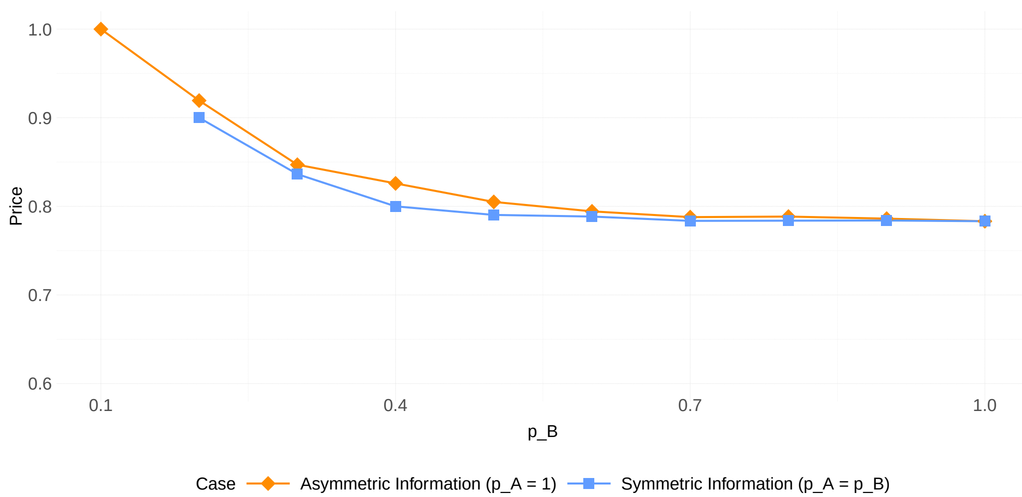
where Has Kamikaze equals 1 if a firm submits the lowest bid but fails to win procurement i for item p in year t due to not satisfying final formalities. The specification includes Item fixed effects (α_p) and interactions of procurement characteristics with year fixed effects (α_{X_i}), such as # Genuine Bidders and Government Institution fixed effects. The figure plots the estimated β_t coefficients for each year t, which capture the difference in logarithm prices in procurements with kamikaze bidding relative to those without it. The vertical lines show 95% confidence intervals with standard errors clustered at the item level.

Figure A7: *Expected Prices in First-Price Auctions with Fixed Costs and a Kamikaze Firm*

Panel A: Symmetric Information



Panel B: Symmetric vs. Asymmetric Information



The figure plots expected prices (y-axis) obtained from numerically solving a first-price auction model with 2 regular bidders (A and B) and one kamikaze bidder (K) who always bids zero. In Panel A, bidders A and B are assumed to believe that K forfeits with probability p (x-axis). Regular bidders face a cost $F \geq 0$ associated with submitting a bid. The bottom line (red circles) represents zero fixed costs ($F = 0$), showing stable prices around 0.67 regardless of the kamikaze's forfeiture probability p as shown in Section C. The middle line (green triangles) shows moderate fixed costs ($F = 0.05$): prices start to increase significantly compared to the benchmark case, especially for low p. The top line (blue squares) shows high fixed costs ($F = 0.15$): prices are higher than in the previous two cases, especially for lower p. Panel B shows expected prices in a first-price auction with fixed costs $F = 0.15$ under two scenarios. In the first scenario (orange diamonds), bidder A believes that the kamikaze bidder forfeits with probability 1, while bidder B believes the kamikaze bidder forfeits with probability p_B (x-axis). In the second scenario (blue squares), both bidders believe the kamikaze bidder forfeits with probability $p = pA = p_B$.

B Case Study of the Kamikaze Strategy

The report TC-035.967/2016-1 from the Brazilian Federal Court of Accounts (or *Tribunal de Contas da União*, TCU) provides a detailed case study of the "kamikaze" bidding tactic (locally known as "*coelho*" or "rabbit") being used in a public electronic auction conducted by the National Institute for Colonization and Agrarian Reform (INCRA) in 2016.

INCRA was looking to hire seven secretaries and ten receptionists through this procurement process. During the auction, two companies - *Semog Construtora e Serviços Terceirizados - Eireli - ME (Semog)* and *M. Burmann Varanda - ME (M. Burmann)* - submitted unusually low bids which raised suspicions.

According to the TCU report, the practice is described as: "*the action of a bidder who presents an excessively low proposal in a bidding process so that other companies give up competing, because they believe that the other competitor would have a price that would not allow them to continue in the dispute. Subsequently, a company that is in collusion with the 'rabbit' offers the second best bid and, with the intentional disqualification of the first, ends up being contracted for a value that could possibly be higher than that which would be obtained without the influence of the 'rabbit'.*" (p. 3)

The report notes that after presenting the lowest bids, both companies quickly withdrew: "*After the companies Semog and M. Burmann took the initiative to withdraw from the dispute and request the disqualification of their last bids*" (p. 5). These withdrawals were made with vague justifications described as "*simple and vague allegations of 'spreadsheet rounding problems' and 'for technical reasons'*" (p. 4).

The TCU report shows that GA Serviços ultimately won the contract with bids significantly higher than those initially offered: "*the final prices and those that came to be contracted were invariably higher than the best bids of the initial phase*" (p. 6). The report includes a table showing that GA's winning bids were between 10-23% higher than the initial low bids by the suspected kamikaze firms:

Comparison of Bids in INCRA Auction

Service	**Initial Low Bids**	**Final GA Bid**	**Difference**
7 Secretaries	R$ 294,000.00 (Semog)	R$ 326,499.60	+11.1%
8 Receptionists	R$ 239,800.00 (Semog)	R$ 258,997.44	+8.0%
1 Receptionist (Araguaína)	R$ 26,700.00 (M. Burmann)	R$ 33,199.92	+24.3%
1 Receptionist (Araguatins)	R$ 27,400.00 (Semog)	R$ 33,199.80	+21.2%

An INCRA employee, Flávio da Silva Mota, identified the suspicious pattern and alerted the auction officials. The report states: "*Having perceived the indications of such a scheme,* *[the whistleblower] notified his hierarchical superior, the auctioneer, support team, as well as the head of the SR-TO/Incra about the indications of the practice of 'rabbit'*" (p. 1). Despite these warnings, the auction administrators failed to take appropriate action to investigate or penalize the companies involved.

Regarding the outcome of the case, the TCU determined that INCRA must complete its internal investigation and report back: "*9.4. determine that the Superintendence of Incra in the State of Tocantins, based on art. 250, item II, of the Internal Rules of the TCU, send to this Court, within thirty days, a conclusive report on the investigations regarding the conduct of bidders in PE 11/2016 and the measures adopted as a result of such results, having as guiding parameters the provisions of art. 7 of Law 10,520/2002*" (p. 32).

Regarding the difficulty in sanctioning companies suspected of kamikaze bidding, it is important to note that the TCU did not share the view presented by the Regional Superintendent. The Superintendent Carlos Alberto da Costa said: "*in view of the absence of elements essential to the verification of the 'rabbit' tactic, of other companies not having given up participating, of not becoming winners the companies pointed to as suspects of the illicit practice, nor of disadvantage occurring for the Administration, such circumstances did not enable the opening of administrative procedure*" (p. 18).

In contrast, the TCU's position was more assertive. The report states: "*In our assessment, there was indeed the practice of the 'rabbit' strategy in Electronic Auction 11/2016, reinforced by other indications of proximity between the companies, in addition to atypical procedures that were decisive in directing the object bid, a situation aggravated by the fact that the companies that most contributed to this environment were not admonished by the INCRA's regional office according to the governing regulations.*" (p. 20). This demonstrates that the Court firmly believed that kamikaze bidding had occurred, despite the challenges in providing definitive legal proof of bid rigging.

C An Illustrative Model of Kamikaze Bidding

This section develops a conceptual framework to rationalize how kamikaze bidding can systematically increase procurement prices and proposes one set of conditions under which such strategies remain effective. We analyze two key mechanisms: strategic deterrence effects when bidders face fixed participation costs, and coordination advantages when some bidders possess superior information about withdrawals.

C.1 Strategic Environment

Consider a first-price procurement auction with N bidders: $N - N_K$ genuine bidders and N_K potential kamikaze bidders. In this auction, the lowest bid wins, and the winner gets awarded the contract in the value of their bid. Each genuine bidder has a private cost of providing the procured good c_i, independently drawn from a uniform distribution on $[0, 1]$. Genuine bidders have private costs and seek to maximize expected profit. The bidders face fixed costs $F > 0$ associated with bidding, such as the opportunity cost of time spent monitoring the auction or maintaining resources during the bidding period.

Kamikaze firms submit extremely low bids but withdraw post-auction, allowing other bidders to win. While the actual Brazilian public auctions follow an open format, for analytical tractability we model the strategic decision-making of genuine bidders using a sealed-bid framework. This simplification captures the key strategic uncertainty that genuine bidders face: after observing kamikaze bids during the open auction, they must form beliefs about withdrawal probabilities when making their final bidding decisions. The open nature of bidding does not eliminate this fundamental uncertainty about which low bids represent genuine competition. Regular bidders face uncertainty about whether kamikaze bids will be forfeited with probability $p \in [0, 1]$. Such p can be symmetric among all bidders ($p_i = \tilde{p}$) or differ with some bidder having a full knowledge ($p_i = 1$) and other bidders unaware of this collusion, believing forfeiture is less certain ($p_j < 1$).

C.2 Benchmark Case

Without loss of generality, consider the case with $N = 3$ bidders: two genuine bidders (A and B) and one kamikaze bidder (K). In this scenario, genuine bidders choose bidding strategies that maximize expected profit:

$$E[\pi] = p \cdot Pr(\text{win among genuine bidders}) \cdot (\text{bid} - \text{cost}) - F$$

Assume first that $F = 0$. Regular bidders A and B will compete with each other to be the second lowest bidder on the off chance that the kamikaze firm's bid will be forfeited. This makes the auction equivalent to one with two $(N - N_K)$ genuine bidders, already mechanically leading to higher expected prices than a standard auction with three (N) bidders. Because the kamikaze firm always withdraws its bid, the expected price in this scenario is the same as if the auction only had two genuine bidders: $E[\text{price}] = \frac{2}{3}$, which is higher than $\frac{1}{2}$ that would be the expected price in a scenario with three genuine bidders, demonstrating that kamikaze bidding reduces effective competition. We next show it more formally.

Equilibrium Bidding Strategy. To find the equilibrium bidding strategy, consider a regular bidder with cost c bidding b. Their expected profit is:

$$E[\pi_i] = p(b_i - c_i)Pr(b_i < b_j) + (1 - p) \cdot 0$$

where $(1 - b)$ is the probability of winning against the other regular bidder, given the uniform cost distribution.

$$Pr(b_i < b_j) = Pr(b(c_j) > b_i) = Pr(c_j > b^{-1}(b_i)) = 1 - b^-1(b_i)$$

So the maximization problem is:

$$maxE[\pi_i] = p(b_i - c_i)(1 - b^{-1}(b_i))$$

Assume $b_i = \alpha + \beta c_i$. Then

$$maxE[\pi_i] = p(b_i - c_i)\left(1 - \frac{b_i - \alpha}{\beta}\right)$$

Conditional on bidding, the first order condition is

$$p(1 - \frac{b_i - \alpha}{\beta}) - \frac{1}{\beta}p(b_i - c_i) = 0$$

Or simplifying

$$(\beta - b_i + \alpha) - (b_i - c_i) = 0$$

$$b_i = \frac{\alpha + \beta}{2} + \frac{1}{2}c_i$$

So $\alpha = \beta = 1/2$ and the solution to this equation yields the optimal bidding strategy:

$$b_i = \frac{1 + c_i}{2}$$

Expected Price. To calculate the expected price, we first condition on the event that the kamikaze bidder removes itself. Given the equilibrium bidding strategy $b(c) = \frac{1+c}{2}$, the expected price conditional on the kamikaze bidder disqualifying is:

$$\begin{aligned}
E[\text{price}] &= E[\min(b(c_1), b(c_2))] \\
&= E[\min(\frac{1 + c_1}{2}, \frac{1 + c_2}{2})] \\
&= \frac{1}{2} + \frac{1}{2}E[\min(c_1, c_2)] \\
&= \frac{1}{2} + \frac{1}{2} \cdot \frac{1}{3} = \frac{2}{3}
\end{aligned}$$

To understand why $E[\min(c_A, c_B)] = 1/3$ for two bidders with costs uniformly distributed on $[0, 1]$:

1. The cumulative distribution function (CDF) for $\min(c_A, c_B)$ is:

$$F(x) = 1 - Pr(\text{both costs} > x) = 1 - (1 - x)^2$$

2. The probability density function (PDF) is the derivative of the CDF:

$$f(x) = 2(1 - x)$$

3. The expected value is then:

$$E[\min(c_A, c_B)] = \int_0^1 x \cdot 2(1 - x)dx = \frac{1}{3}$$

This result, combined with the bidding strategy $b(c) = (1 + c)/2$, leads to the expected price of 2/3.

Since the price is only determined by the bids of the two regular bidders, and the kamikaze bidder always forfeits, the unconditional expected price is equal to the conditional expected price:

$$E[\text{price}] = E[\text{price}] = \frac{2}{3}$$

C.3 Fixed Costs and Strategic Withdrawal

The benchmark case assumes no bidding costs in auctions. However, when bidders face fixed costs $F > 0$ associated with bidding, such as the opportunity cost of time spent monitoring the auction or maintaining resources during the bidding period, kamikaze strategies become significantly more effective at inflating prices, especially when the probability of kamikaze firm withdrawing is lower.

The introduction of fixed costs creates a circular dependence: participation decisions depend on expected profits, which depend on optimal bids, which in turn depend on winning probabilities that are influenced by other bidders' participation decisions. Due to this strategic interdependence, we solve the model numerically by iteratively updating bidding strategies and participation decisions until convergence. Panel A of Figure A7 illustrates these patterns by plotting expected prices obtained from numerically solving the model with one kamikaze firm and two genuine bidders. With zero fixed costs ($F = 0$), prices remain stable around 2/3 regardless of kamikaze withdrawal probability p. However, with positive fixed costs ($F = 0.05$ and $F = 0.15$), prices are higher compared to zero fixed costs, especially for low values of p.

The mechanism operates through effective participation costs. As fixed costs F increase or the perceived probability p of kamikaze forfeiture decreases, regular bidders face higher effective participation costs (F/p). This shift prompts bidders to reassess their strategies: anticipating that other regular bidders may opt out due to these unfavorable conditions, remaining bidders submit less aggressive (higher) bids. These higher bids serve a dual purpose: they increase profit margins, making participation worthwhile despite elevated risks, and compensate for the reduced winning probability due to potential kamikaze participation. Thus, the framework predicts that higher fixed costs combined with lower forfeiture probabilities lead to less aggressive bidding as bidders adapt to the changing auction environment.

C.4 Information Asymmetries and Coordination

If we further relax the assumption of p being symmetric among all bidders ($p_i = \tilde{p}$), this effectively allows bidder A to collude with the kamikaze firm, giving this bidder the certainty that the kamikaze firm will always withdraw ($p_A = 1$). In contrast, bidder B, unaware of this collusion, believes forfeiture is less certain ($p_B < 1$).

Under this asymmetry, bidder B faces higher effective costs and increased uncertainty, leading them to bid less aggressively or not participate. Anticipating this reduced competition, bidder A strategically exploits its informational advantage by submitting higher bids. The numerical analysis presented in Panel B of Figure A7 shows that the equilibrium prices in this asymmetric case exceed those from the symmetric case where both bidders share the same beliefs about the probability that the kamikaze bid will be withdrawn ($p_A = p_B$).

This information asymmetry fundamentally alters auction dynamics: coordinated bidders need not submit the most competitive bids to win, as they know that apparently superior kamikaze bids will disappear. Most importantly, this mechanism can lead to systematically less efficient outcomes. Coordinating firms may win auctions despite having higher costs than genuine bidders, since their informational advantage allows them to avoid the aggressive bidding that non-coordinating firms would require to overcome kamikaze uncertainty.

C.5 Empirical Support for Model's Assumptions

Our theoretical framework predicts that kamikaze strategies become more effective under specific conditions that amplify their impact on genuine bidders' behavior. We examine two key factors that determine when these strategies are most successful.

Fixed Costs: Simultaneous Auctions Our model shows that fixed bidding costs amplify kamikaze effectiveness by making participation less attractive for genuine bidders when they face uncertainty about kamikaze withdrawals. Brazilian electronic procurement provides a natural setting to test this mechanism, as these auctions often involve simultaneous bidding across multiple items. Half of firms in each procurement auction participate in other auctions within the same batch, with an average of 23 simultaneous auctions occurring for related goods and services during each procurement event.

Unlike in traditional single-item auctions where bidders can focus on optimizing outcomes in a singular context, simultaneous bidding forces bidders to make strategic allocation decisions across multiple auctions. Engelbrecht-Wiggans and Weber (1979) highlight that capacity-constrained bidders strategically vary their bid aggressiveness, offering competitive bids for some contracts while submitting less competitive bids for others they are willing to win only at premium rates. The presence of kamikaze bidding in some auctions introduces a layer of risk for bidders constrained by capacity, making it risky for them to significantly lower their prices in response to such tactics. Instead, they may opt to be more aggressive in other simultaneous auctions.

Column V of Internet Appendix Table A6 tests this by interacting kamikaze presence with above-median simultaneous auctions. The results show significantly stronger kamikaze effects when more simultaneous auctions compete for bidders' resources, consistent with resource constraints amplifying the strategic deterrence effects of kamikaze bidding.

Uncertainty: Multiple Kamikaze Firms Our model predicts that when regular bidders perceive a lower probability of kamikaze bid forfeiture (lower p), they submit less aggressive bids. This effect can be amplified when there are multiple kamikaze firms in the same auction. With K kamikaze firms, assuming independence, the probability that all kamikaze bids will be forfeited is p^K, which is lower than p for $p < 1$.[22] This lower probability reduces regular bidders' perceived chances of winning and the incentives of continuing in the auction.

To test this implication, we interact the *Has Kamikaze* dummy in equation (4) with the number of kamikaze firms in the particular auction, grouped into buckets. Indeed, about 40% of the auctions with kamikazes have more than one kamikaze firm that does not submit the required documents after the auction. The findings in Internet Appendix Table A14 strongly support our model's predictions. Column II shows that auctions with a single kamikaze firm exhibit a 5.25% higher price compared to similar auctions without kamikaze firms. This effect monotonically increases with the number of kamikaze firms, reaching 32.5% for auctions with five or more kamikaze firms. This pattern is consistent with the framework where multiple kamikaze firms give an appearance of competition, leading to less competitive bidding behavior of genuine firms and higher procurement prices.

These findings demonstrate that kamikaze strategies are most effective when genuine bidders face resource constraints and heightened uncertainty about withdrawal probabilities, supporting our theoretical framework's predictions about the conditions that enable sustained kamikaze success.

[22] From the perspective of genuine bidders who cannot distinguish coordinated from independent behavior, multiple kamikaze firms appear as independent threats.

D Firm Characteristics and Roles

In this section, we report the analysis of the characteristics and roles of kamikaze firms.

Firm Characteristics Brazilian firm registry *Receita Federal* allows us to observe a few firm characteristics such as firm age and size.[23] We thus study if the kamikaze firms are consistently smaller and younger than the winning firms, i.e., they are likely to be special-purpose entities, and whether they take stable roles with the winning firms in the repeated auctions.

We first estimate the following specification as we focus on individual characteristics:

$$y_{ipj} = \alpha_{ip} + \beta X_{ipj} + e_{ipj} \tag{7}$$

where y_{ipj} is either the $p(kamikaze)_{ipj}$—a dummy equal to 1 if bidder j at procurement i for item p is a kamikaze firm and zero otherwise—or $p(winner)_{ipj}$—a dummy equal to 1 if bidder j at procurement i for item p is the winner and zero otherwise. The main explanatory variables, X_{ipj} are firm characteristics at the procurement i, item p, and firm j level—firm age and size. This specification controls for procurement-by-item fixed effects, which effectively compares the characteristics of firms participating in the same auction.

Internet Appendix Table A15 presents the findings. Columns I and II show that relative to the other participants in the same auction, smaller and younger firms, i.e., those that are more opaque, are more likely to be kamikazes. In particular, firms that were created less than 3 years ago (young firms) are 3.24 p.p more likely to engage in the kamikaze strategy than other auction participants. Also, small firms are 3.89 p.p. more likely to be kamikaze firms. Columns III and IV look at the corresponding characteristics of winners in kamikaze auctions. We see that young and small firms are 1.68 p.p. and 5.32 p.p. less likely to be winners, as compared to other participants in the same auction.

Firm Roles To study the dynamics of the roles that kamikaze and winning firms take and thus to understand whether the kamikaze and winning firms engage in bid rotation or have stable roles (especially if they are likely related through ownership), we investigate whether firms that engage in kamikaze strategies in some auctions are likely to continue following the same strategy in the other auctions.

We initially consider whether firms switch *across different procurements*. To do that, we

[23]Small firms are defined as per official Brazilian government classification. These are firms that have at most BRL 4.8 million in yearly revenue (USD 1 million) and no more than 99 employees.

estimate the following regression:

$$y_{ipjt} = \alpha_{ip} + \beta_1 \cdot X_{jt} + e_{ipjt} \tag{8}$$

where y_{ipjt} is a role in the procurement i, item p, firm j and time t: either whether the firm j is a kamikaze firm in procurement i to purchase item p at year t, or whether the firm j was a winner of procurement i, item p at year t. Similarly, X_{jt} is either $\textit{Was Kamikaze}_{j,t-1:t-12}$, or $\textit{Was Winner in Kamikaze Procur}_{j,t-1:t-12}$. $\textit{Was Kamikaze}_{j,t-1:t-12}$ is a dummy equal to 1 if firm j was a kamikaze firm in another procurement in the past 12 months. $\textit{Was Winner in Kamikaze Procur}_{j,t-1:t-12}$ is a dummy equal to 1 if firm j was a winner in procurement in the past 12 months with the presence of a kamikaze firm.

Internet Appendix Table A16 presents the findings. In columns I and II, y_{ipjt} is a dummy equal to one if a firm j is a kamikaze firm in procurement i to purchase item p at year t and 0 otherwise. Column I shows that firms that were engaging in a kamikaze strategy in the previous year are more likely to continue doing so in the focal procurement. In addition, as per column II, winning firms in kamikaze auctions in the previous year are less likely to engage in kamikaze themselves in the focal procurement. These results suggest that kamikaze firms adopt constant roles in their coordinating strategies. Similarly, in columns III-V, y_{ipjt} is a dummy equal to one if a firm j is a winner firm in procurement i to purchase item p at year t and 0 otherwise. Column III shows that previous kamikazes are less likely to be winners, while columns IV and V show that previous winners in kamikaze auctions are more likely to continue winning. Column V includes a control for general winning experience (*Was Winner*) to show that the effect is specific to winning in kamikaze auctions rather than general firm quality.

We also test switching *within the same procurement* but across different items purchased in the same procurement. We implement the following specification:

$$y_{ipjt} = \alpha_{ip} + \beta_1 \cdot X_{ip^*jt} + e_{ipjt} \tag{9}$$

where y_{ipjt} is a role in the procurement i, item p, firm j and time t: either whether the firm j is a kamikaze firm in procurement i to purchase item p at year t, or whether firm j was a winner of procurement i, item p at year t. Similarly, X_{ip^*jt} is either $\textit{Was Kamikaze}_{ip^*jt}$ or $\textit{Was Winner in Kamikaze Procur}_{ip^*jt}$. $\textit{Was Kamikaze}_{ip^*jt}$ is a dummy equal to 1 if firm j was a kamikaze firm in procurement i purchasing item $p^* \neq p$. $\textit{Was Winner in Kamikaze Procur}_{ip^*jt}$ is a dummy equal to 1 if firm j was a winner in procurement i purchasing item $p^* \neq p$.

Internet Appendix Table A17 shows the findings that are very similar to the ones found across procurements as reported in Internet Appendix Table A16: kamikaze firms are less likely to win other auctions of the same procurement, and winners of auctions with kamikaze firms are more likely to win other auctions, especially when these other auctions also have a kamikaze firm.