Kamikazes in Public Procurements *

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Abstract

Using granular auction data on 15 million item purchases in Brazilian public procurements between 2005-2021, we document a widespread pattern that the lowest bidder ("kamikaze") does not satisfy required formalities after the auction is concluded, which allows the second-lowest bid to win the auction. Such a pattern can be observed in up to 15-20% of procurement auctions and results in 15-17% higher procurement prices as compared to similar auctions procuring the same product or service items, organized by the same government institutions, and even having the same winning firm. Kamikaze firms are smaller, younger, and tend to be co-owned by the same ultimate owner as the winning firm. Using observed kamikaze behaviour as a marker, we aim to measure how higher procured product and services prices contribute to real outcomes by public service providers by reducing the budget available for sourcing other items and the quality of the procured items. Taking the case of hospital mortality data, we see an increased number of deaths in the four quarters after an increased fraction of procurement auctions involving kamikazes. Similarly, we observe an increase in the road accidents following the road service contracts involving kamikaze firms.

Keywords: procurement auctions, bid-rigging, shared ownership, non-market collusion outcomes

JEL Classification: G34, G38, L22, L41

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Governments spend significant resources purchasing goods and services from private companies.[1] Such procurements are typically organized in the form of the competitive auctions to mitigate the concerns of corruption (Transparency International, 2015). Yet even the auctions can be rigged by the colluding private agents, aiming to drive up their revenue from supplying goods or services to the public sector (OECD, 2009). One direct implication from the inefficiencies resulting from bid rigging is that financially constrained governments that overspend on rigged procurements might have to save remaining resources and could end up providing lower quality public services, not least since the quality of services procured in the rigged contracts might not be of the highest level to start with.

Quantifying such negative externalities of bid rigging on the quality of public services is challenging as, apart from the judicially prosecuted cases, outsiders do not observe most of the rigged auctions. Using granular auction data on about 15 million distinct item purchases in public procurements in Brazil between 2005 and 2021, we document one unique widespread pattern that we attribute to bid rigging motives and we later use as a "bid rigging marker". As this marker is ex post directly observable to the outside econometrician, we then study how financial constraints endogenous to collusion affect real outcomes, such as health quality in Brazilian public hospitals, and road quality in Brazilian highways.

In particular, in Brazil's electronic first-price open auctions, the country's predominant procurement auction method, we observe that the lowest bidder ("kamikaze") often drops out from the auction after the auction is concluded, e.g., by not satisfying certain formalities, which allows the second-lowest bidder to win the auction. The difference in prices between the kamikaze bid and the eventually winning bid of this second-lowest bidder is on average 30%. Such a pattern is rather common and can be observed in up to 15-20% of procurement auctions in Brazil over our sample period.[2]

[1] Public procurements constitute 12% of the global GDP (Bosio et al., 2022).

[2] Similar practices has also been observed in other jurisdictions. For example, Antitrust Primer by 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."

We first ask whether such pattern results in worse procurement outcomes such as higher product prices that the government pays for acquiring the goods and services as compared to the similar auctions. If such observed behavior is non-strategic (e.g., occurs because smaller firms mis-estimate their costs and/or capacities to deliver the products), other firms' bidding strategy should not depend on the presence of the mis-estimating firm's bid, and the second-lowest bidder price should not be different from the price for the same item in the similar procurements without kamikaze behaviour.

We observe that procurement prices are 15-17% higher in the auctions with the kamikaze pattern, i.e., when the lowest bidder drops out from the auction and the second-lowest bidder wins. Our result is identified after comparing kamikaze procurements to other auctions that involve exactly the same products and services being purchased (i.e., controlling for item x year fixed effects), the same number of bidders (i.e., controlling for the number of participants x year fixed effects or even item x number of participants x year fixed effects), and the same public buyers (i.e., government institution x year fixed effects).

Yet procurements with and without kamikaze firms can still have different prices because the participating firms might be of different types. For example, such overpricing could be explained if winners in kamikaze procurements are less efficient than those in non-kamikaze procurements. However, when we condition on auctions having the same eventually-winning firm, we still observe substantially higher prices of products and services when such win comes after some other firm drops out from the auction as compared to those cases when the winning firm is the lowest bidder itself.

Moreover, as compared to the similar auctions, in such auctions with kamikazes, we observe fewer bids by other participants and the bids by other bidders exhibit lower dispersion in the dollar values of bids, suggesting less aggressive competitive strategies. In addition, the more aggressive the kamikaze is itself, i.e., the lower is its eventually forfeited bid, the higher is the overpricing when we compare the winning bid to similar auctions. We also see similar patterns if there are multiple kamikazes involved in the auction. These findings

suggest that the kamikaze strategy could act as an intimidation signal to other competitors that helps the bid-rigging cartel to win the said auction.

We further look at the characteristics of the kamikaze firms. Comparing firms participating in the same procurements and bidding for the same individual product items, kamikaze firms are smaller and younger than the winning firms. These firms tend to adopt constant roles in coordinated strategies, i.e., the previous kamikaze firms are less likely to win and more likely to continue adopting the kamikaze strategy in the future, while the previous winners in kamikaze procurements are more likely to continue winning, especially when there is another kamikaze firm. They are also more likely to be based in the same geographic area and are more likely to share the same ultimate owners, compared to an average relationship with the other participants of the same procurement. As shared ownership allows more effective alignment in pursuing coordinated strategies and driving up product prices, the observations of frequent shared ownership between kamikaze and winning firms and their constant roles are particularly supportive of the interpretation that such behavior is not accidental and suggests the likely presence of bid rigging.

Having established that kamikaze behavior is associated with overpricing and can be explained by bid rigging, we turn to using observed kamikaze behaviour as a marker/filter to measure how much higher procured prices contribute to negative real outcomes in public services. This can happen in at least two ways. First, bid rigging in general and kamikaze behavior in particular place financial strains on government institutions and such overspending can negatively impact future public budgeting. The financial constraints arising endogenously from collusion could have negative externalities on the ability of the involved agencies to provide essential services to the public. Second, the winners in kamikaze procurement might not be the most efficient firms with the highest quality suppliers to start with, again hindering public institutions to provide the highest quality service.

We take two contexts to study these negative real externalities. First, we investigate the impact of kamikaze procurements on hospital mortality rates by examining the purchase of

essential medicines. Based on the information from 61 federal hospitals in Brazil, we compare the future death rates in hospitals that acquire medicines for the same disease and in the same quarter, but have different kamikaze firms in these procurements. We see an 10% increase in the hospital mortality rate in the four quarters following the purchase of essential medicines in hospitals whose procurement of essential medicines involved the kamikaze behaviour. As essential medicines purchased in auctions have precise specifications and do not differ in the quality but can rather differ in procured price, this observed effect is likely explained by reduced residual budgets to acquire additional essential medicines, detrimentally affecting hospital mortality.

As a second piece of evidence suggesting the real effects of bid-rigging, we investigate the incidence of traffic accidents after road maintenance and repair contracts are awarded in procurements with and without kamikaze behaviour. Roads with contracts awarded to firms in kamikaze procurements see 13.5% increase in road accidents and 11.5% rise in the number of victims and such a finding holds even comparing the road repairs with similar complexity. Different from hospitals, however, in the case of road repairs, the budgets for a particular repair task are fixed, while the procured service quality is difficult to contract on by the procuring agency. This suggests another channel how bid rigging in kamikaze public procurement can affect real outcomes — via lower quality of the procured services themselves.

Taken together, these two sets of results imply that overpricing in government auctions could result in serious negative non-market effects. These results also bring to the attention one particular coordination strategy – kamikazes – that firms frequently use and that is associated with significant overpricing. They also provide support for Kumar et al. (2015), who suggest that one reason why firms exist is to give the impression of competition in public procurements.

Our paper primarily relates to the literature on cartel detection (e.g. Porter and Zona, 1993, 1999; Bajari and Ye, 2003; Chassang et al., 2022) by studying one particular observable

mechanism of how firms engage in bid rigging behavior. We refrain from rationalizing the market equilibrium in how such behavior when the lowest bidders consistently remove themselves from the auction is sustainable in a dynamic game with other bidding participants, or which policy interventions would attenuate the prevalence of these strategies. Instead, we use this observed kamikaze behavior as the marker to study the non-market outcomes, such as hospitalization and road repairs, as a way to quantify the broader real outcomes resulting from firm collusion in the procurement auctions. With this we also relate to the studies on broader macroeconomic implications and other externalities resulting from public procurement auctions such as firm growth (Ferraz et al., 2022), productivity (di Giovanni et al., 2022), and healthcare assess (Barkley, 2023).

Previous public procurement literature has looked at abnormally low tenders and the defaulting winners (e.g. Spulber, 1990; Zheng, 2011; Decarolis, 2014) but has interpreted it as a non-strategic behavior. For example, the European Commission (2002) mentions that *"contractors who intentionally submit abnormal tenders might be those who seek an ex post renegotiation of the terms of the contract. They could also be firms in bad financial conditions that, however, are either reluctant to lay off their employees or are in search of a contract in order to obtain a cash advance from their client or bank"*. In our case, we study how such non-winning lowest bids in the public procurements are exploited strategically, possibly as part of the bid rigging process rather than occur due to misestimation of the cost components or a failed strategy of the expected contract renegotiation.

Finally, as we observe that the coordination is particularly prevalent in the cases where the winning firm and the kamikaze share ultimate owners, we relate to the finding in Charoenwong and Asai (2020) that shared ownership networks are positively associated with higher contract prices in public procurement auctions.[3] We study one particular mechanism—kamikazes—how the coordination via shared ownership can be implemented in the public procurements. In addition, related to the broader corporate ownership implications, we pro-

[3]Also, see Schmalz (2021) for a recent review of the literature of common ownership and industrial organization.

vide new evidence of how firm ownership can affect patient health outcomes (e.g. Eliason et al., 2019; Gupta et al., 2021; Ashtari Tafti and Hoe, 2022; Liu, 2022; Schmalz and Xie, 2022) and have other externalities such as reduced road quality.

1 Data

The main dataset comes from the ComprasNET portal, an electronic platform for government institutions to conduct procurements. As such, it contains information on the universe of federal public procurements in Brazil. This information includes procurement outcomes, descriptions of the items purchased, and the bidding history of each auction. In the end, the data includes 4.8 thousand government institutions purchasing 139 thousand distinct items and services in 15 million auctions from September 2005 to August 2021. An average auction in the data had, on average, seven participants, and these participants made 4.7 bids each. All in all, the dataset contains about 450 million distinct bids.

We match items to their official government registry – i.e., *Cadastro dos Materiais* (CADMAT) for products and *Cadastro dos Serviços* (CADSER) for services. Table A1 in the Internet Appendix provides an example list with selected products and services in the sample.

Table A2 presents a selected list of government institutions present in the database. Figure 1 plots the number of government institutions per municipality in Brazil. Out of the 5,500 municipalities, federal government institutions in the dataset are present in about 1,049 distinct municipalities. The municipalities with the most government agencies are Brasília (381), followed by the Rio de Janeiro (373), Belém (172), and São Paulo (167). Figure 2 plots the number of distinct participants per municipality. The municipalities with the most number of participants are São Paulo (10,108), Brasília (8,503), Rio de Janeiro (8,371), and Belo Horizonte (4,684), suggesting imperfect overlap between the federal geographies and the firm locations.

In our main analysis on the real non-market outcomes, we rely on a few secondary sources.

First, we take data on hospital deaths in Brazil from DataSUS, a publicly available dataset on the healthcare performance of hospitals that serve patients through the Brazilian Unified Health System (*Sistema Unificado de Saúde - SUS*). Second, we use the data on accidents on Brazilian roads from *Polícia Rodoviária Federal* (or Federal Highway Patrol), which has information on road accidents and victims on the all the Brazilian highways that are under federal purview.

Finally, we gather firms' registry data from the *Receita Federal*, which contains information on firms' location, industry, size category, and ownership structures for the universe of Brazilian firms. Table 1 presents the summary statistics of the main outcome variables used in the paper.

2 Institutional Background

Procurements for common goods and services in Brazil are held by two main procedures. The first one is the bid waiver (i.e., *Dispensa de Licitação*), with which purchases are made without the competitive bidding. Since bid waivers may give too much discretion to public officials, this procedure is allowed under specific circumstances such as for small-value contracts, emergency situations, or the cases with the lack of competitors. For all the other purposes, the law requires the use of competitive bidding (i.e., *Pregão Eletrônico*), when the public contract to sell goods and services to the government is awarded to the lowest bidder.

A government institution undergoes several stages when it purchases items via competitive auctions. Initially, it must get regulatory approval for the purchase in question. After the clearance is obtained, the institution has to issue a detailed notice, explaining the item(s) demanded as well as clarifying the other proceedings of the auction. The institution then collects proposals from potential bidders. These proposals can be collected until the date when the electronic bidding is going to take place and are then evaluated to see if they meet the minimal criteria. Bidders from the approved proposals are then authorized to participate

in the bidding stage. The bidding is made electronically on the ComprasNET portal. While bidders cannot observe the other bidders' identities,[4] they can see the values of other bids being made.

The first bids are automatically entered as per the initial proposals submitted by the bidders. Once the bidding stage starts, the bidders can decide whether to submit another bid, which must be lower than the same bidder's previous bid, but that can be larger than the lowest overall bid across all bidders at that moment. After some time, the bidding stage ends, and the auctioneer declares the winner to be the participant that offered the lowest bid. The winner is then asked to submit documents that prove the firm's going concern status. If the required documents are accepted, the winner is approved by the auctioneer, the public contract is signed, and the procurement ends. If, however, the winner fails to deliver the documents, or they are not in order, then the winner is disqualified, and the second-lowest bidder is declared the winner. This process is repeated until the documents of one of the bidders are approved by the auctioneer, at which point, the public contract is signed, and the procurement ends.

In this paper, we study the situations when the original winner(s) do not win because they fail to be approved after the bidding ends. While such failure to deliver these documents may be an honest mistake or be a result of cost mis-estimation, we analyze whether such behavior can be attributed to strategic coordination and whether that has any real non-market outcomes. In fact, Brazilian regulators and monitors have raised some suspicions that participants exploit such behavior as part of a bid-rigging process,[5] and policy makers and industry professionals in Brazil coined these bidders as "kamikazes", not least since they

[4] The auctioneer observes the identities of all bidders. Since 2014, the auctioneers also has access to the ultimate ownership structures of the auction participants. This information is unobservable to other participants.

[5] *Tribunal de Contas da União* (TCU)'s sentence no. 1793/2011 paragraph 69 argues that *"it is possible that there are companies reducing prices in order to discourage the participation of other bidders in the bidding stage, later withdrawing from the bidding to benefit another company that is participating in the collusion, which, in turn, ends up being hired without having presented the best proposal, thus causing damage to the Administration."*

tend to have bids that are much lower than the second-lowest bid. Following this, we define the winning firms that fail to submit the documents for approval as kamikazes and auctions that have at least one such kamikaze firm as kamikaze procurement auctions.

Using data from ComprasNET, we find that such a pattern is relatively common. In Figure 3, we plot the dollar value of the fraction of kamikaze auctions in Brazil semiannually between 2005-2021. We see that up to 15-20% of procurement auctions in Brazil can be considered as having a kamikaze firm. In addition, we find that kamikaze firms' bids are, on average, 30% lower than the winners' bids in the same auctions (Figure 4), confirming the aggressive bid behavior of these to-be-forfeit bids.

Despite the relative prominence of such behavior and the available solutions discussed in the literature such as the requirement to submit the documents for the prequalification before the auction, the posting of the monetary commitment such as surity bond, or the imposition of fines, the enforcement against such behavior is limited in Brazil. While according to Federal Law No. 10,250/2022, *"whoever ... fails to deliver or present false documentation required for the bidding process ..."* may be banned from participating in public procurements for a maximum of five years, in practice such punishments are rarely given and so it is unlikely to have a strong deterrence effect. According to the Open Data on Public Purchases Portal, during our sample period 83 thousand firms were disqualified after winning the auction, but only 13 thousand, or 15%, received legal actions against this behavior.[6] Conditional on being 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.

According to the TCU, limited enforceability of the law is partially explained by the lack of the manpower of the government institutions to go ahead with the administrative processes against every firm that does not follow the auction rules by the book.[7] Moreover,

[6]This data can be obtained at https://compras.dados.gov.br/docs/fornecedores/ocorrencia_fornecedor.html.

[7]See TCU's sentence no. 1793/2011, paragraph 90.

corporate lawyers tend to argue that in the absence of the proof of willful misconduct, firms should not be severely punished for what could have been a good-faith mistake, not least since extreme punishments have a risk of reducing the number of potential competitors in future auctions, leading to overpricing.

3 Empirical Analysis on Kamikaze Firms

Before we discuss the real non-market outcomes, we establish the relevance of kamikaze behavior as a marker for bid rigging. This section discusses our approach in this. We first present the results on whether auctions with kamikaze firms are associated with higher product prices than the similar auctions. We then explore the heterogeneity of the effect based on the observed kamikaze behavior. We next study the characteristics of the kamikaze firms and the dynamics of kamikaze behavior.

3.1 Overpricing

We first study whether auctions that present kamikaze behavior have different outcomes than other similar auctions. We define kamikaze behavior when the lowest bid firms do not win the procurement, because they either fail to deliver documents, or are disqualified due to inconsistencies. While this behavior could raise suspicions of coordination with other market participants, it may also be non-strategic (e.g., smaller firms might mis-estimate their costs and/or capacities to deliver the products). In the latter scenario, non-kamikaze firms' bidding strategy should not depend on the bids of kamikaze firms, and thus the second-lowest bidder price should not be different from the lowest price for the same item in similar procurements without the kamikazes. Thus, we should not expect differences in the eventual procurement outcomes.

We implement the following specification:

$$y_{ipt} = \alpha_{pt} + \alpha_{X_i t} + \beta \cdot HasKamikaze_{ipt} + e_{ipt} \quad (1)$$

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

Since there might be general trends in the prices of particular products and services, we control for item x year fixed effects and thus compare kamikaze and non-kamikaze auctions for the same item purchased in a particular year. We also control # of participants x year fixed effects to make sure that kamikaze and non-kamikaze auctions that we compare have similar potential for competition, e.g., an auction with two bidders might have inherently different dynamics than an auction with four bidders. Finally, by controlling for government institution x year fixed effects, we abstract from the differences between government institutions, e.g., in the capacity of different institutions to procure different quality products or services.

Table 2 presents the results of the specifications in which the outcome variable is the log of the procured price. In the specifications reported in column I, we control for for item x year fixed effects and # of participants x year fixed effects, and show that purchases in auctions with kamikaze firms have 16.9% higher prices. Overall, the results suggest that the kamikaze behavior leads to significant overpricing compared to similar procurements.

It is possible, however, that the incidence of kamikaze in public procurements is positively correlated with the level of inefficiency of the government institution procuring goods and services. Kamikaze firms could target those government institutions that would enable this bid rigging strategy due to inefficiency or ignorance of the auctioneer. To address this

concern, column II additionally adds government institution x year fixed effects to take into account possible differences in efficiency across Brazilian institutions. The estimated coefficients stay in the same order of magnitude of 15%.

We reestimate the equation 1 annually to see if there are any time trends in overpricing. Figure 5 shows that the overpricing of kamikaze procurements is consistently above 12% across all years in the sample.

While prices are higher for procurements with kamikaze firms, one may ask why such an outcome arises. We estimate the equation 1 but instead as two additional outcome variables we look at # of bids per bidder and the standard deviation across all the bids by non-kamikaze firms within an auction. Columns III to VI of Table 2 show how the bidding behavior changes in procurements with versus without kamikaze firms. There are, on average, 1.1 to 1.4 fewer bids per non-kamikaze bidder in the presence of kamikaze firms (columns III and IV). That suggests that even controlling for the same original number of participants we see less aggressive competition. Columns V and VI show that the standard deviation across all the prices that were bid within an auction are 19-21 percentage points (relative to its mean) lower in kamikaze procurements. All in all, these results suggest that kamikaze firms are successful in curbing competition by decreasing the number of bids as well as the aggressiveness of non-kamikaze bidders.

One potential alternative explanation for the differences in outcomes might be differences in characteristics of the winners in kamikaze versus non-kamikaze procurements. If winners are more productive in the cases with kamikazes than in the cases without kamikazes, than this might explain why kamikaze procurement prices are higher. We address this concern by comparing procurements within the same winner, i.e., holding the eventually winning firm providing the same item constant by controlling for winner x item x year fixed effects in Table 3. While the magnitude of the coefficient on log of prices drops by half to about 7% (columns I and II), it remains statistically significant. Further, the number of bids by bidder is also lower in kamikaze auctions by about 1 unit, on average (columns III and

IV), while the volatility of the bids is lower by 16 percentage points (relative to its mean) in columns V and VI. Overall, while kamikaze firms seem to lead to more inefficient winners that generally charge larger prices than winners in non-kamikaze auctions, we still find significant overpricing when we compare procurements within the same eventual winner.

Another potential alternative explanation is that once observing a kamikaze firms' bid, all non-kamikaze bidders are then aware that this firm is not really competing. Assuming that this is the case, then the non-kamikaze bidders will behave as if there are fewer effective competitors in the auction, and bid less aggressively. We then estimate the same regression as equation 1, but now compare procurements with the same number of actual competitors, that is defined as the number of total competitors minus the number of kamikaze firms. Table 4, columns I to II, presents the results. Overall, they suggest that even if all kamikaze firms would not be seen as the actual competitors by all other bidders, the overpricing would amount to 8.3-10.7%.

3.2 Heterogeneous Effects

We further validate kamikaze strategy as the marker for bid rigging by studying the heterogeneity of the effect based on the observed kamikaze behavior. If the kamikaze behavior successfully affects procurement outcomes, one would expect that these consequences are higher when this behavior is more aggressive (*intensive margin*), or there are more firms using this strategy in the same auction (*extensive margin*).

We start with the intensive margin and reestimate regression 1 by adding the interaction term of the *Has Kamikaze* dummy with dummies based on how much lower the kamikaze bid was relative to the winning bid ("discount"). Table 5 presents these results that show that the lower was the kamikaze bid compared to the winning bid (i.e., the higher the discount), the higher was the resulting overpricing of the procurement. This result is consistent with the intimidation by kamikaze firms: Potential competitors are less likely to continue bidding if they observe an excessively low bid by the lowest bidder. As a result, the second lowest

bid is going to be much higher than what it should be in the absence of kamikaze firms.[8]

We then study the extensive margin and we again add interaction terms to equation 1, where we interact the *Has Kamikaze* dummy with the number of kamikaze firms in the particular auction, as grouped into buckets. Indeed, the same auction can have multiple kamikaze firms that do not submit the required documents after the auction. These kamikaze firms could be part of the same coordinated group or come from competing groups. Table 6 presents the results that paint a similar picture to the intensive margin results. We see that more kamikaze firms in the same auction correspond to more overpriced winning bids, as compared to similar auctions. In addition, with the higher number of kamikaze firms we see a lower number of bids per bidder, and the less volatile the bid values within the auction. All in all, these results suggest that multiple kamikaze firms signal a more committed strategy (and are likely coordinating between themselves) that leads to an even larger overpricing.

3.3 Characteristics and Dynamic Roles of Kamikaze Firms

Before we delve into studying real outcomes, we study the characteristics of these kamikaze firms that helps us ascertain of their roles in the strategic bidding rings. We also study their relationships with the winning firms, both in terms of the static comparisons and also the dynamic interactions between winning firms and kamikaze firms.

3.3.1 Firm Characteristics

We first take information on firm characteristics from a Brazilian firm registry *Receita Federal*. While we can extract only limited information, we are able to consider the firm's age, size, location, and its ownership structures.

[8]Note that this effect is not mechanical as we are not comparing kamikaze bid with the winning bid but we are comparing the winning bid in an auction with kamikazes with a winning bid in similar auctions—after controlling for the same item-year, number of participants-year, and same government institution-year fixed effects—without kamikazes.

We then estimate the following specification:

$$y_{ipj} = \alpha_{ip} + \beta X_{ipj} + e_{ipj} \tag{2}$$

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(win$_{ipj}$)*—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. This specification adds procurement-item fixed effects, which effectively compares the characteristics of firms participating in the same auction.

Table 7 presents the results. 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 three years ago are 3.24% more likely to engage in the kamikaze strategy than other auction participants. Also, small firms are 3.89% more likely to be kamikaze firms.[9] Columns III and IV look at the corresponding characteristics of winners in kamikaze procurements. We see that young and small firms are 1.68% and 5.32% less likely to be winners, as compared to other participants in the same auction.

We further look at the relationships between kamikaze firms and the winning firms. In particular, in columns V to VII, we only focus on the non-kamikaze participants in auctions with kamikazes, resulting in a smaller sample size of our tests. Our explanatory variables are then the dummies that firm j is from the same municipality (column V), is from the same zip code (column VI), and has the same owner (column VII) as the kamikaze firm in procurement i and item p.

We indeed find that winning firms are more likely to be connected to kamikaze firms relative to the other participants in the same procurement. Those participants that are from

[9]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.

the same municipality or the same zip code as the kamikaze firm are 3.17% and 8.51% more likely to win the procurements in the auctions with kamikaze firms. More importantly, we observe shared ownership structures between kamikazes and winning firms. Those participants that have at least one owner in common with the kamikaze firm are 6.91% more likely to win the procurements. This finding provides the most direct evidence on the possible ex ante coordination between winners and kamikaze firms.[10]

We further expand on this observation of the shared ownership between the kamikaze and winning firms. Since kamikaze firms are more likely to share owners with the potential winners, we study a follow-up question of the interactive effect of an auction having both kamikaze firms and firms with common owners.

That is, we reestimate the regression 1 by interacting the *Has Kamikaze* dummy with the dummy on whether kamikaze firms and winner firms shared ownership. Table 8 presents the results. Columns I to III show that procurements with common owners and kamikazes are 3.5-6.3% more overpriced than procurements with kamikaze firms but without common owner winning firms. This effect represents 23%-42% of the unconditional effect of having a kamikaze firm in an auction. These results that overpricing is larger in those cases when kamikaze and winning firms are linked via shared ownership give the most direct evidence of the potential coordination in actions between these sets of firms.

3.3.2 Dynamic Roles

How do kamikaze firms coordinate with the winners? 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.

[10] One alternative explanation could have been that kamikaze firms do not coordinate their behavior with the winning firms ex ante but "blackmail" them ex post. The overpricing then could reflect anticipated side payment to the kamikaze firm. Given that kamikaze and winning firms share ownership, such arm's-length ex post bargaining is less likely.

We initially consider whether firms switch across different procurements. To do that, we run the following regression:

$$y_{ipjt} = \alpha_{ip} + \beta_1 \cdot X_{jt} + e_{ipjt} \tag{3}$$

where y_{ipjt} is a role in the procurement i, product 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 *Was Kamikaze*$_{j,t-1:t-12}$, or *Was Winner in Kamikaze Procur*$_{j,t-1:t-12}$. *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. *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.

Table 9 shows the results. 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 procurements 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-VII, 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. Columns III and IV show that previous winners in kamikaze procurements are more likely to continue winning. This, however, could be explained by the fact that these firms are indeed the best providers of goods and services and thus have a higher unconditional probability of winning. Columns VI and VII, then, remove those firms from the control group that did not win in any procurement in the past year. We see consistent results. In column VII, we see that past winners in kamikaze procurements are particularly more likely to win in those procurements that also have the observed kamikaze behavior.

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

$$y_{ipjt} = \alpha_{ip} + \beta_1 \cdot X_{ip^*jt} + e_{ipjt} \tag{4}$$

where y_{ipjt} is a role in the procurement i, product 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 *Was Kamikaze*$_{ip^*jt}$ or *Was Winner in Kamikaze Procur*$_{ip^*jt}$. *Was Kamikaze*$_{jp^*j}$ is a dummy equal to 1 if firm j was a kamikaze firm in procurement i purchasing product $p^* \neq p$. *Was Winner in Kamikaze Procur*$_{ip^*jt}$ is a dummy equal to 1 if firm j was a winner in procurement i purchasing product $p^* \neq p$.

Table 10 shows the results. The findings are very similar to the ones found across procurements: kamikaze firms in some auctions are less likely to win auctions of other auctions of the same procurement, and winners of some auctions with kamikaze firms are more likely to win other auctions, specially when these other auctions also have a kamikaze firm.

4 Real Effects

So far this paper has shown that the kamikaze behavior has a strong effect on prices of items purchased by government institutions. We further discuss how kamikaze behavior is related to real non-market outcomes. We argue that such effects can happen in at least two ways. The first reason is that bid rigging in general and kamikaze behavior in particular place financial strains on government institutions and such overspending can negatively impact future public budgeting. The financial constraints arising endogenously from collusion could have negative externalities on the ability of the involved agencies to provide essential services to the public. To this effect, we first show that purchasing more items in kamikaze procurements leads to higher financial strain on government institutions by affecting the likelihood

that the same item will be purchased in the future. We then study whether this is associated with the negative effects in the public service provision in the context of medical sector after the essential medicine procurements had the involvement of kamikaze firms.

The second reason how the quality of public services can be affected could be that the winners in kamikaze procurement might not be the most efficient firms with the highest quality suppliers to start with, again hindering public institutions to provide the highest quality service. In this regard, we investigate the road accidents that likely follow lower quality of road maintenance by the winners of kamikaze auctions.

4.1 Institution Budgets

To understand how kamikaze procurements affect future public purchases of the same product, we estimate the following specification across all government institutions in our sample:

$$ln(q)_{ap,t+1:t+4} = \alpha_{ap} + \alpha_{pt} + \beta \cdot \$KamikazeProcur(as\%of\$Procur)_{apt} + e_{apt} \tag{5}$$

where the independent variable $KamikazeProcur(as\%of\$Procur)_{apt}$ is the fraction of total value purchased in procurements with kamikaze firms as a fraction of total procured by institution a for item p at year t. The dependent variable is the log of total quantity purchased by institution a for item p during the following 4 quarters.

Column I of Table 11 shows that the higher the value purchased of item p by institution a at year t in kamikaze procurements, the lower quantity purchased for the same item in the subsequent year. Column II shows that the probability of that the institution will initiate another purchase also decreases in the following year. Overall, it seems that kamikaze procurements can affect the likelihood of future purchases due to the added pressure on the budget constraints.

4.2 Hospital Mortality

We analyze data on hospital mortality for 61 federal hospitals in Brazil obtained from DataSUS. We then investigate how kamikaze auctions affect the health outcomes of these hospitals. For each purchase of medicine in kamikaze procurements we select all the non-kamikaze procurements of essential medicines for the same disease and month of purchase as the control observation. We then stack these events into cohorts and compare health outcomes the date of purchase in a "stacked" difference-in-differences method (e.g., Gormley and Matsa, 2011) approach as follows:

$$y_{iet} = \alpha_{ie} + \alpha_{et} + \beta Kamikaze_{ie} \cdot Post_{et} + e_{iet} \tag{6}$$

where y_{iet} refers to the mortality rate of hospital i in cohort e at time t. $Kamikaze_{ie}$ is a dummy equal to one if the procurement in hospital i for cohort e is a kamikaze procurement and zero otherwise. $Post_{et}$ is a dummy equal to one after the purchase in cohort e and zero otherwise. We control for cohort x year fixed effects and hospital x cohort fixed effects.

Table 12 shows the results for this specification. In column I, we can see that kamikaze procurements of essential medicines lead to a 0.31 p.p. higher mortality rate for the particular cause. We next split the cases into the terminal and non-terminal causes. Columns II and III show that the increase in mortality only happens in the case of non-terminal causes. This result points out that the purchase of overpriced essential medicines tend to increase the mortality rate, especially for those diseases that could be preventable with the increased quality of hospital service provision. Finally, in column IV we report the results in which we focus the sample on the top 5 preventable death causes[11] and we see that kamikaze procurements increase the mortality rate by 0.74 p.p, again suggesting that the preventable cases are particularly elastic to the reduced hospital budgets.

One concern when comparing hospitals that experienced a kamikaze procurement against

[11] In our sample, the top 5 preventable deaths in terms of mortality rate are infections, heart, respiratory, perinatal, and blood diseases.

those that did not could be that the trends in the mortality outcomes are different before the treatment. In Figure 6, we provide a visual representation of the effect of kamikaze procurements on hospital mortality. The graph shows that the differences in the mortality rates is only observable after the occurrence of the kamikaze procurements. Before these procurements, treated and control hospitals seemed to follow similar trends. Moreover, in terms of the dynamics, we see that the effect is not imminent, i.e., it takes time for the effect on inventories to result in the shortages, but also transient, i.e., kamikaze procurements have limited effect beyond 1-2 years after which the budgets are likely adjusted accordingly.

Overall, these findings suggest that for financially constrained government institutions bid-rigging could reduce budgets available for other procurement auctions and thus reduce the quality of public services provision.

4.3 Road Accidents

In addition to hospital mortality, we also look at the road quality as another real outcome of bid rigging in kamikaze procurements. We take information from 952 road repair procurements, and compare road accidents following the road repairs that involve kamikaze procurements and those that do not involve kamikaze procurements. That is, for each road repair kamikaze procurement, we select non-kamikaze road repairs awarded in the same month. We then estimate a regression in a "stacked" difference-in-differences approach similarly as in the equation 6 above. Data on road accidents comes from *Polícia Rodoviária Federal* that records information on the accidents

Table 13 shows the results for this specification. In columns I and III, we can see that road repair contracts awarded in kamikaze procurements are associated with a 13.5% higher number of accidents and a 11.5% higher number of victims, respectively. As procurement auction design could be correlated with the complexity of road repairs, we further control for the differences in the extension of these road repairs in terms of kilometers. As seen in columns II and IV, we see almost identical coefficients. Figure 7 shows that the effect on

accidents only comes after the purchase and that there are no clear diverging trends before the procurement.

That being said, the channel how kamikaze procurements result in lower quality of public services could be different than that explaining an increase in the hospital mortality rates. In the latter case, the essential medicines have precise specifications and are unlikely to differ in the quality but can rather differ in procured price. This, however, implies reduced residual budgets to acquire non-essential medicines and services which eventually affect the hospital mortality, especially in preventable cases. On the other hand, different from hospitals, the budgets for a particular road repair task are rather fixed, while the procured service quality is difficult to contract on by the procuring agency. This suggests another channel how bid rigging in kamikaze public procurement can affect real outcomes — via lower quality of the procured services themselves. Indeed, Figure 7 on road accidents suggests a more permanent effect, likely coming from lower level of the installed road quality that is difficult to adjust ex post, as compared to the more transient effect in Figure 6 on hospital mortality where budgets eventually mean revert if kamikaze procurements are not repeated.

5 Conclusion

This study presents evidence of a prevalent bid-rigging tactic that results in excessive pricing in first-price open bid auctions. In the kamikaze strategy, bidders intentionally submit low bids to deter competitors, but then purposely give up the contract so that the second-lowest bidder is declared the winner. This pattern can be observed in up to 15-20% of procurement auctions in Brazil and leads to a 15-17% increase in prices paid. We also find that the ultimate winner and the kamikaze firm are more likely to be located in the same zip code and more likely to share a common owner.

In the end, this bid-rigging behavior results in government institutions overspending and negatively impacting the quality of public services, as demonstrated by higher mortality rates

in hospitals that purchase more overpriced items due to this tactic, as well as higher number of road accidents following rigged road maintenance procurements that could be associated with lower quality of repair work.

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Table 1: *Summary Statistics*

	n	mean	std dev	p1	median	p99
	I	II	III	IV	V	VI
ln(price)	14,967,474	3.11	2.32	-2.30	3.00	9.40
# Participants	14,967,474	6.84	5.51	1	5	165
No. Kamikaze firms	14,967,464	0.36	1.10	0	0	54
# bids per bidder	14,913,088	4.26	5.51	1.00	2.06	33.50
$\sigma(bid)/\overline{bid}$	14,913,075	0.75	0.98	0.00	0.41	5.35

Table 2: *Kamikaze Firms and Procurement Outcomes*

	$\log(\text{price})_{ipt}$		# bids per bidder_{ipt}		$\sigma(bid)/\overline{bid}_{ipt}$	
	I	II	III	IV	V	VI
$\text{Has Kamikaze}_{ipt}$	0.1690***	0.1497***	-1.450***	-1.188***	-0.2124***	-0.1910***
	(0.0079)	(0.0060)	(0.0243)	(0.0216)	(0.0066)	(0.0052)
Obs	14,967,464	14,967,464	14,913,078	14,913,078	14,913,065	14,913,065
R^2	0.865	0.870	0.185	0.232	0.363	0.429
Item*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
# of Participants*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution*Year FEs		Yes		Yes		Yes

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

$$y_{ipt} = \alpha_{pt} + \alpha_{X_i t} + \beta \cdot HasKamikaze_{ipt} + e_{ipt}$$

$\text{Has Kamikaze}_{ipt}$ equals to 1 if a firm has the lowest bid, but does not win procurement i for product p in year t, and 0 otherwise. y_{ipt} is is either log of the price for item p purchased in procurement i at time t (columns I and II), the average number of bids per bidder of log of procurement i for item p at time t (columns III and IV), or the ratio the standard deviation of the bid value to the average bid value (columns V and VI). $\#\text{ bids per bidder}_{ipt}$ and $\sigma(bid)/\overline{bid}_{ipt}$ are constructed by only considering bids of non-kamikaze firms. α_{pt} is a item-year fixed effects; $\alpha_{X_i t}$ are interactions of procurement i characteristics (X_i) and year fixed effects such as # of participants x year fixed effects and government institution x year fixed effects. Column I adds Item-Year and # of Participants*Year fixed effects, effectively comparing procurements with the same item purchased and the same number of participants in the same year. Column II also includes Gov Institution-Year fixed effects. Finally, column III includes Gov Institution*Year and # of Participants-Item-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 3: *Kamikaze Firms and Procurement Outcomes: Controlling for the Same Winner*

	$\log(\text{price})_{ipjt}$		# bids per bidder_{ipjt}		$\sigma(bid)/\overline{bid}_{ipjt}$	
	I	II	III	IV	V	VI
Has Kamikaze_{ipt}	0.0734***	0.0706***	-0.9805***	-0.8987***	-0.1593***	-0.1519***
	(0.0051)	(0.0042)	(0.0228)	(0.0274)	(0.0077)	(0.0068)
Obs	14,965,840	14,965,840	14,911,454	14,911,454	14,911,441	14,911,441
R^2	0.928	0.930	0.564	0.582	0.698	0.722
Winner*Item*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
# of Participants*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution*Year FEs		Yes		Yes		Yes

This table compares outcomes of procurements with and without the presence of Kamikaze firms. The main independent variable Has Kamikaze_{ipt} is a dummy equal to 1 if procurement i for item p at year t had a Kamikaze firm and zero otherwise. Kamikaze firms are those that have the lowest bid, but do not win the procurement because it does satisfy the final formalities to be declared the winner. The dependent variables are the log of the price for item p purchased in procurement i with winner firm j at time t (columns I and II), the average number of bids per bidder of log of procurement i for item p with winner firm j at time t (columns III and IV), and the ratio the standard deviation of the bid value to the average bid value (columns V and VI). # bids per bidder_{ipjt} and $\sigma(bid)/\overline{bid}_{ipjt}$ are constructed by only considering bids of non-kamikaze firms. Even columns add Winner*Item*Year – comparing procurements with the same winner, item and year – and # Participants*Item*Year fixed effects comparing procurements with the same number of participants, items, and year. Odd columns go a step further and also add Gov. Institution*Year FEs. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 4: *Kamikaze Firms and Procurement Outcomes: Actual Competitors*

	$\log(\text{price})_{ipt}$		# bids per bidder_{ipt}		$\sigma(bid)/\overline{bid}_{ipt}$	
	I	II	III	IV	V	VI
Has Kamikaze_{ipt}	0.1070***	0.0843***	-1.164***	-0.8829***	-0.0570***	-0.0350***
	(0.0057)	(0.0044)	(0.0222)	(0.0174)	(0.0036)	(0.0026)
Obs	14,967,464	14,967,464	14,913,078	14,913,078	14,913,065	14,913,065
R^2	0.865	0.870	0.179	0.227	0.366	0.431
Item*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
# of Actual Competitors*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution*Year FEs		Yes		Yes		Yes

This table compares outcomes of procurements with and without the presence of Kamikaze firms. Kamikaze firms are those that have the lowest bid but do not win the procurement because it does satisfy the final formalities to be declared the winner. The dependent variable are the log of the price of item p purchased in procurement i at time t (columns I to III), the average number of bids per bidder of log of procurement i for item p at time t (columns IV to VI) and the ratio of the standard deviation of the bid value to the average bid value (columns VII to IX). # bids per bidder_{ipt} and $\sigma(bid)/\overline{bid}_{ipt}$ are constructed by only considering bids of non-kamikaze firms. Columns I, IV and VII add Item-Year and # of Actual Competitors*Year fixed effects, effectively comparing procurements with the same item purchased and the same number of actual competitors in the same year. Actual competitors is defined as the number of total participants minus the number of kamikaze firms in procurement p for item i. Columns II, V, and VIII also include Gov Institution-Year fixed effects. Finally, columns III, VI, and IX include Gov Institution*Year and # of Actual Competitors-Item-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 5: *Kamikaze Firms and Procurement Outcomes: Effects by Kamikaze Intensity*

	$\log(\text{price})_{ipt}$		# bids per bidder_{ipt}		$\sigma(bid)/\overline{bid}_{ipt}$	
	I	II	III	IV	V	VI
Has Kamikaze_{ipt} (0% to 10% Discount)	0.0824***	0.0643***	-1.026***	-0.7537***	-0.1603***	-0.1330***
	(0.0062)	(0.0044)	(0.0200)	(0.0188)	(0.0057)	(0.0041)
Has Kamikaze_{ipt} (10% to 25% Discount)	0.1723***	0.1484***	-2.126***	-1.812***	-0.2609***	-0.2358***
	(0.0090)	(0.0067)	(0.0355)	(0.0297)	(0.0081)	(0.0065)
Has Kamikaze_{ipt} (25% to 50% Discount)	0.3573***	0.3294***	-2.294***	-2.052***	-0.3240***	-0.3120***
	(0.0131)	(0.0115)	(0.0406)	(0.0329)	(0.0084)	(0.0072)
Has Kamikaze_{ipt} (50% to 100% Discount)	0.4574***	0.4430***	-1.759***	-1.672***	-0.2987***	-0.3090***
	(0.0118)	(0.0103)	(0.0307)	(0.0255)	(0.0083)	(0.0074)
Obs	14,967,464	14,967,464	14,913,078	14,913,078	14,913,065	14,913,065
R^2	0.865	0.870	0.186	0.234	0.364	0.430
Item*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
# of Participants*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution*Year FEs		Yes		Yes		Yes

This table compares outcomes of procurements with and without the presence of Kamikaze firms. The main independent variable Has Kamikaze_{ipt} is a dummy equal to 1 if procurement i for item p at year t had a Kamikaze firm and zero otherwise. Kamikaze firms are those that have the lowest bid, but do not win the procurement because it does satisfy the final formalities to be declared the winner. I divide this variable into four based on how much the Kamikaze firm's bid was lower than the winning bid, i.e., 0% to 10%, 10% to 25%, 25% to 50%, and 50% to 100%. We interact The dependent variables are the log of the price for item p purchased in procurement i at time t (columns I to III), the average number of bids per bidder of log of procurement i for item p at time t (columns IV to VI), and the ratio the standard deviation of the bid value to the average bid value (columns VII to IX). # bids per bidder_{ipt} and $\sigma(bid)/\overline{bid}_{ipt}$ are constructed by only considering bids of non-kamikaze firms. Columns I, IV, and VII add Item-Year and # of Participants*Year fixed effects, effectively comparing procurements with the same item purchased and the same number of participants in the same year. Columns II, V, and VIII also include Gov Institution-Year fixed effects. Finally, columns III, VI, and IX include Gov Institution*Year and # of Participants-Item-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively. See caption of Table 2 for further details of the specifications.

Table 6: *Number of Kamikaze Firms and Procurement Outcomes*

	$\log(\text{price})_{ipt}$		# bids per bidder_{ipt}		$\sigma(bid)/\overline{bid}_{ipt}$	
	I	II	III	IV	V	VI
1 $\text{Kamikaze Firm}_{ipt}$	0.0993***	0.0853***	-1.067***	-0.8338***	-0.1399***	-0.1239***
	(0.0051)	(0.0039)	(0.0176)	(0.0158)	(0.0050)	(0.0037)
2 $\text{Kamikaze Firms}_{ipt}$	0.2075***	0.1922***	-1.945***	-1.685***	-0.2655***	-0.2430***
	(0.0082)	(0.0057)	(0.0305)	(0.0257)	(0.0077)	(0.0062)
3 $\text{Kamikaze Firms}_{ipt}$	0.2965***	0.2770***	-2.290***	-2.025***	-0.3545***	-0.3361***
	(0.0116)	(0.0088)	(0.0397)	(0.0352)	(0.0099)	(0.0084)
4 $\text{Kamikaze Firms}_{ipt}$	0.3799***	0.3607***	-2.424***	-2.158***	-0.4230***	-0.3975***
	(0.0153)	(0.0102)	(0.0466)	(0.0397)	(0.0129)	(0.0100)
5+ $\text{Kamikaze Firms}_{ipt}$	0.5331***	0.5128***	-2.391***	-2.129***	-0.5300***	-0.5188***
	(0.0231)	(0.0190)	(0.0640)	(0.0544)	(0.0154)	(0.0127)
Obs	14,967,464	14,967,464	14,913,078	14,913,078	14,913,065	14,913,065
R^2	0.865	0.870	0.186	0.234	0.366	0.431
Item*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
# of Participants*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution*Year FEs		Yes		Yes		Yes

This table compares outcomes of procurements with and without the presence of Kamikaze firms. The main independent variables are dummies equal to 1 if the firm had 1, 2, 3, 4 or more than 5 Kamikaze firms in procurement i for item p at year t and zero otherwise. Kamikaze firms are those that have the lowest bid, but do not win the procurement because it does satisfy the final formalities to be declared the winner. I divide this variable into four based on how much the Kamikaze firm's bid was lower than the winning bid, i.e., 0% to 10%, 10% to 25%, 25% to 50%, and 50% to 100%. We interact The dependent variables are the log of the price for item p purchased in procurement i at time t (columns I to III), the average number of bids per bidder of log of procurement i for item p at time t (columns IV to VI), and the ratio the standard deviation of the bid value to the average bid value (columns VII to IX). # bids per bidder_{ipt} and $\sigma(bid)/\overline{bid}_{ipt}$ are constructed by only considering bids of non-kamikaze firms. Columns I, IV, and VII add Item-Year and # of Participants*Year fixed effects, effectively comparing procurements with the same item purchased and the same number of participants in the same year. Columns II, V, and VIII also include Gov Institution-Year fixed effects. Finally, columns III, VI, and IX include Gov Institution*Year and # of Participants-Item-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively. See caption of Table 2 for further details of the specifications.

Table 7: *Characteristics of Kamikaze Firms*

	p(kamikaze$_{ipj}$)		p(win$_{ipj}$)				
	I	II	III	IV	V	VI	VII
young firm$_{ipj}$	0.0324***		-0.0168***				
	(0.0031)		(0.0015)				
small firm$_{ipj}$		0.0389***		-0.0532***			
		(0.0046)		(0.0033)			
p(same muni)$_{ipj}$					0.0317***		
					(0.0019)		
p(same zip)$_{ipj}$						0.0851***	
						(0.0143)	
p(same owner)$_{ipj}$							0.0691***
							(0.0202)
Obs	24,989,145	24,989,145	24,989,830	24,989,830	19,740,737	19,740,737	19,740,737
R^2	0.176	0.175	0.086	0.088	0.166	0.165	0.165
Procurement*Item FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table shows the characteristics of kamikaze firms. 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(win$_{ipj}$) – a dummy equal to 1 if bidder j at procurement i for item p is the winner and zero otherwise in columns III to VII. Kamikaze firms are those that have the lowest bid, but do not win the procurement because it does satisfy the final formalities to be declared the winner. The independent variables are the probability that firm j was created less than 3 years ago (columns I and III),the probability that firm j is small, as defined by the official government classification (columns II and IV), the probability that firm j is from the same municipality or zip code as the kamikaze firms (columns V and VI, respectively), and the probability that firm j has the same owner as the kamikaze firm (column VII). All columns add Procurement*Item fixed effects. Columns V to VII drop Kamikaze firms from the sample. Standard errors clustered at the firm level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 8: *Kamikaze Firms and Procurement Outcomes: Shared Ownership*

	$\log(\text{price})_{ipt}$		# bids per bidder_{ipt}		$\sigma(bid)/\overline{bid}_{ipt}$	
	I	II	III	IV	V	VI
$\text{Has Kamikaze}_{ipt}$	0.0804***	0.0556**	-0.6413***	-0.4948***	-0.0307	-0.0181
	(0.0232)	(0.0176)	(0.0553)	(0.0470)	(0.0193)	(0.0199)
$\text{Has Common Owners}_{ipt}$	0.1677***	0.1488***	-1.460***	-1.198***	-0.2129***	-0.1920***
	(0.0081)	(0.0061)	(0.0236)	(0.0208)	(0.0064)	(0.0049)
$\text{Has Common Owners}_{ipt} \cdot \text{Has Kamikaze}_{ipt}$	0.0390^{+}	0.0351*	0.5013***	0.4020***	0.0240	0.0407*
	(0.0203)	(0.0147)	(0.0494)	(0.0442)	(0.0198)	(0.0180)
Obs	14,967,464	14,967,464	14,913,078	14,913,078	14,913,065	14,913,065
R^2	0.865	0.870	0.185	0.232	0.363	0.429
Item*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
# of Participants*Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Gov Institution*Year FEs		Yes		Yes		Yes

This table compares outcomes of procurements with and without the presence of Kamikaze and shared-owned firms. The main independent variable $\text{Has Kamikaze}_{ipt}$ is a dummy equal to 1 if procurement i for item p at year t had a Kamikaze firm and zero otherwise. Kamikaze firms are those that have the lowest bid, but do not win the procurement because it does satisfy the final formalities to be declared the winner. $\text{Has Common Owners}_{ipt}$ is a dummy equal to 1 if procurement i, item p at year t have at least two firms with the same owner. The dependent variable is the log of the price of item p procured in procurement i at time t. Column I adds Item-Year and # of Participants*Year fixed effects, effectively comparing procurements with the same item purchased and the same number of participants in the same year. Column II also includes Gov Institution-Year fixed effects. Finally, column III includes Gov Institution*Year and # of Participants-Item-Year fixed effects. Standard errors clustered at the item level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively. See caption of Table 2 for further details of the specifications.

Table 9: *Switching Across Procurements*

	p(kamikaze)$_{ipjt}$		p(win)$_{ipjt}$				
	I	II	III	IV	V	VI	VII
Was Kamikaze$_{j,t-1:t-12}$	0.0074***		-0.0013				
	(0.0003)		(0.0014)				
Was Winner in Kamikaze Procur$_{j,t-1:t-12}$		-0.0020***		0.0326***	0.0339***	0.0206***	0.0199***
		(0.0005)		(0.0013)	(0.0016)	(0.0015)	(0.0017)
Was Winner in Kamikaze Procur$_{j,t-1:t-12}$ · Has Kamikase$_{ipt}$					-0.0050***		0.0032*
					(0.0013)		(0.0015)
Obs	83,086,792	83,086,800	83,086,792	83,089,393	83,089,382	76,836,196	76,836,185
R^2	0.341	0.304	0.341	0.148	0.148	0.158	0.158
Sample	All	All	All	All	All	Previous Winners	Previous Winners
Procurement*Item FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table shows whether kamikaze firms and procurement winners switch positions across procurements. That is, within a procurement-product pair, we compare the probability that a firm j is a kamikaze or a winner in the current procurement auction i based on its past participation in other procurements over the last 12 months. We implement the following specification:

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

where y_{ipjt} is an outcome for procurement i, product p, firm j and time t: the probability that firm j is a kamikaze firm in procurement i to purchase item p at year t and 0, otherwise (columns I to III), and the probability that firm j was a winner of procurement i, item p at year t, and 0 otherwise (columns IV to VII). X_{jt} is either *Was Kamikaze*$_{j,t-1:t-12}$ or *Was Winner in Kamikaze Procur*$_{j,t-1:t-12}$. 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. 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. All columns add Procurement*Item fixed effects. Standard errors clustered at the firm level are presented in parentheses. $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 10: *Switching Within Procurements*

	p(kamikaze)$_{ipjt}$		p(win)$_{ipjt}$				
	I	II	III	IV	V	VI	VII
Was Kamikaze$_{ip^*jt}$	0.0480***		-0.0226***				
	(0.0008)		(0.0013)				
Was Winner in Kamikaze Procur$_{ip^*jt}$		-0.0377***		0.1712***	0.1456***	0.0571***	0.0375***
		(0.0007)		(0.0018)	(0.0020)	(0.0017)	(0.0020)
Was Winner in Kamikaze Procur$_{ip^*jt}$ · Has Kamikase$_{ipt}$					0.1091***		0.1420***
					(0.0019)		(0.0022)
Obs	82,695,885	82,695,950	82,698,357	82,698,462	82,698,453	48,499,901	48,499,893
R^2	0.35112	0.30637	0.14330	0.17834	0.18095	0.20511	0.20696
Sample	All	All	All	All	All	Previous Winners	Previous Winners
Procurement*Item FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table shows whether kamikaze firms and procurement winners switch positions within procurements. 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 an outcome for procurement i, product p, firm j and time t: the probability that firm j is a kamikaze firm in procurement i to purchase item p at year t and 0, otherwise (columns I to III), and the probability that firm j was a winner of procurement i, item p at year t, and 0 otherwise (columns IV to VII). X_{ip^*jt} is either *Was Kamikaze*$_{ip^*jt}$ or *Was Winner in Kamikaze Procur*$_{ip^*jt}$. Was Kamikaze$_{jp^*j}$ is a dummy equal to 1 if firm j was a Kamikaze firm in procurement i purchasing product $p^* \neq p$. Was Winner in Kamikaze Procur$_{ip^*jt}$ is a dummy equal to 1 if firm j was a winner in procurement i purchasing product $p^* \neq p$. All columns add Procurement*Item fixed effects. Standard errors clustered at the firm level are presented in parentheses. $^+$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 11: *Kamikaze Procurements on Future Purchases*

	$\log(q)_{ap,t+1:t+4}$	$\text{prob}(q)_{ap,t+1:t+4}$
	I	II
\$ Kamikaze Procur (as % of \$ Procur)$_{apt}$	-0.0288*	-0.0040**
	(0.0137)	(0.0013)
Obs	417,886	2,868,026
R^2	0.958	0.588
Gov Institution*Item FEs	Yes	Yes
Item*Quarter FEs	Yes	Yes

This table shows the effect of kamikaze procurements of product item p by government institution a on future purchases by the same government institution a of the same product item p. The data is collapsed at the government institution a, item p and year t level. The independent variable is the fraction of total value purchased in procurements with kamikaze firms as a fraction of total procured by institution a for item p at year t. The dependent variables are the log of total quantity purchased by institution a for item p during the following 4 quarters, i.e. t+1 to t+4 (column I), and the probability that institution a will purchase item p in the following 4 quarters (column II). All columns add Gov Institution*Item and Item*Quarter fixed effects. Standard errors clustered at the institution-item level are presented in parentheses $^+$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 12: *Kamikaze Essential Medicine Procurements and Hospital Mortality*

Causes	mortality rate$_{iet}$			
	All	Terminal	Non-Terminal	Main
	I	II	III	IV
kamikaze$_{ie}$·post$_{et}$	0.0031***	-0.0040	0.0035***	0.0074***
	(0.0008)	(0.0028)	(0.0008)	(0.0018)
Obs	68,122	3,291	64,831	16,235
R^2	0.896	0.938	0.891	0.920
Event*Hospital*Cause	Yes	Yes	Yes	Yes
Cause*Event*Year	Yes	Yes	Yes	Yes

This table compares hospital excess deaths outcomes between essential medicine purchased via kamikaze vs non-kamikaze procurements. For each kamikaze auction we select non-kamikaze auctions that happened in the same month. We stack these events in a "stacked" DID design as in the following equation:

$$y_{iet} = \alpha_{ie} + \alpha_{et} + \beta Kamikaze_{ie} \cdot Post_{et} + e_{iet}$$

where the dependent variable y_{iet} is the ratio between deaths and number of inpatients in hospital i, event e and year t. The main independent variable kamikaze$_{ie}$ is a dummy equal to one if the purchase of essential medicine for hospital i in event e was done via a kamikaze procurement and zero otherwise. Post$_{et}$ is a dummy equal to one after the contracts were awarded and zero otherwise. Standard errors clustered at the road-event level are presented in parentheses $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Table 13: *Kamikaze Road Repair Procurements and Road Accidents*

	log(No. Accidents)$_{iet}$		log(No. Victims)$_{iet}$	
	I	II	III	IV
kamikaze$_{ie}$·post$_{et}$	0.1349***	0.1331**	0.1145**	0.1167**
	(0.0406)	(0.0406)	(0.0359)	(0.0359)
log(extension)$_{ie}$·post$_{et}$		0.0083		-0.0117
		(0.0138)		(0.0095)
Obs	7,343	7,343	7,295	7,295
R^2	0.976	0.976	0.974	0.974
Event*Road	Yes	Yes	Yes	Yes
Event*Year	Yes	Yes	Yes	Yes

This table compares outcomes between road repair contracts awarded via kamikaze vs non-kamikaze procurements. For each kamikaze auction we select non-kamikaze auctions that happened in the same month. We stack these events in a "stacked" DID design as in the following equation:

$$y_{iet} = \alpha_{ie} + \alpha_{et} + \beta Kamikaze_{ie} \cdot Post_{et} + e_{iet}$$

where the dependent variable y_{iet} is either the log of the number of accidents in road repair i, event e and year t (columns I and II) or the log of the number of victims in road repair i, event e and year t (columns III and IV). The main independent variable kamikaze$_{ie}$ is a dummy equal to one if road repair i of event e was awarded in a kamikaze procurement and zero otherwise. Post$_{et}$ is a dummy equal to one after the contracts were awarded and zero otherwise. log(extension)$_{ie}$ is the log of the extension of the road repair in kilometers. Standard errors clustered at the road-event level are presented in parentheses $^{+}$, *, **, and *** denote significance of 10%, 5%, 1%, and 0.1%, respectively.

Figure 1

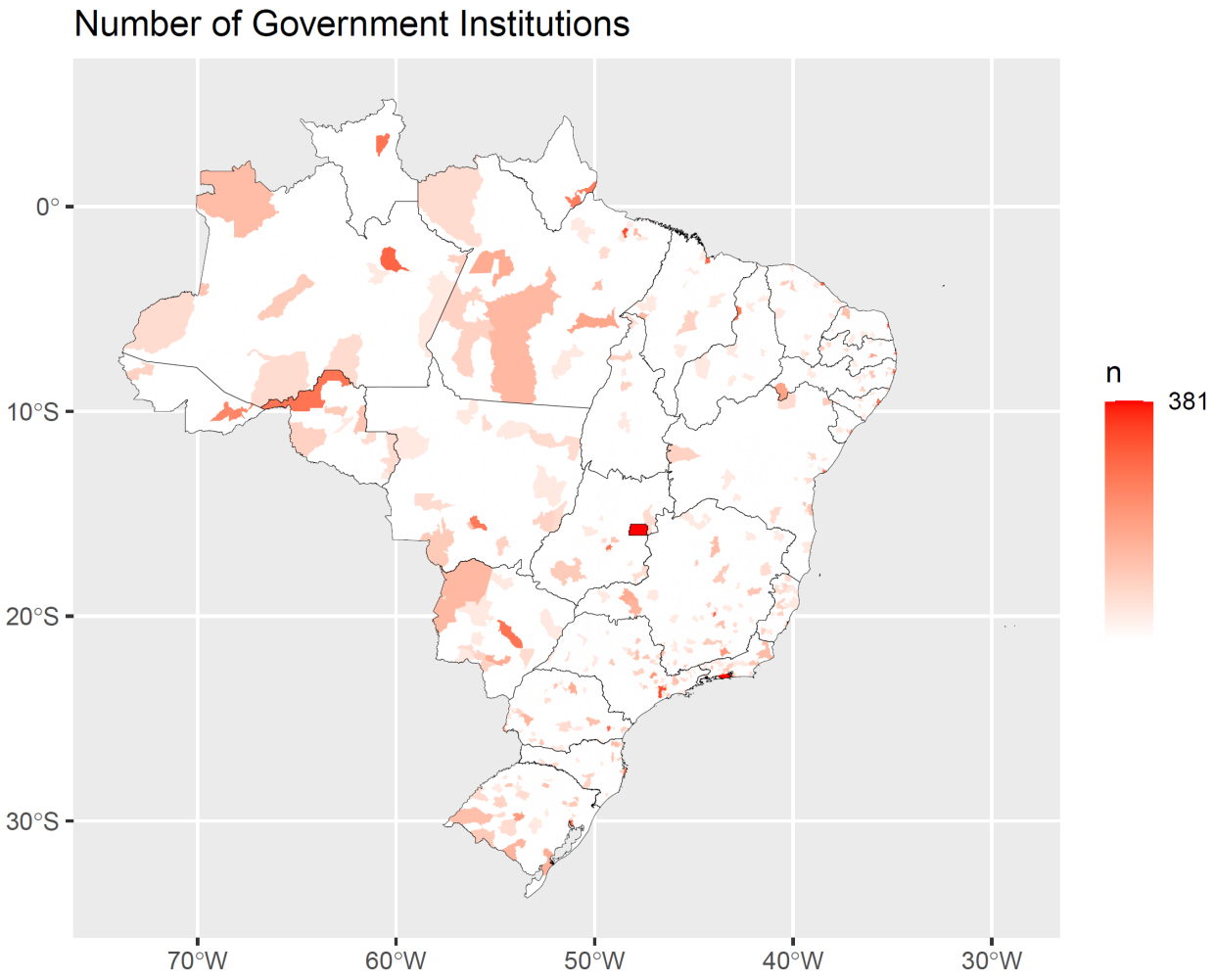

Number of Government Institutions
0°
10°S
20°S
30°S
70°W
60°W
50°W
40°W
30°W
n
381

Figure 2

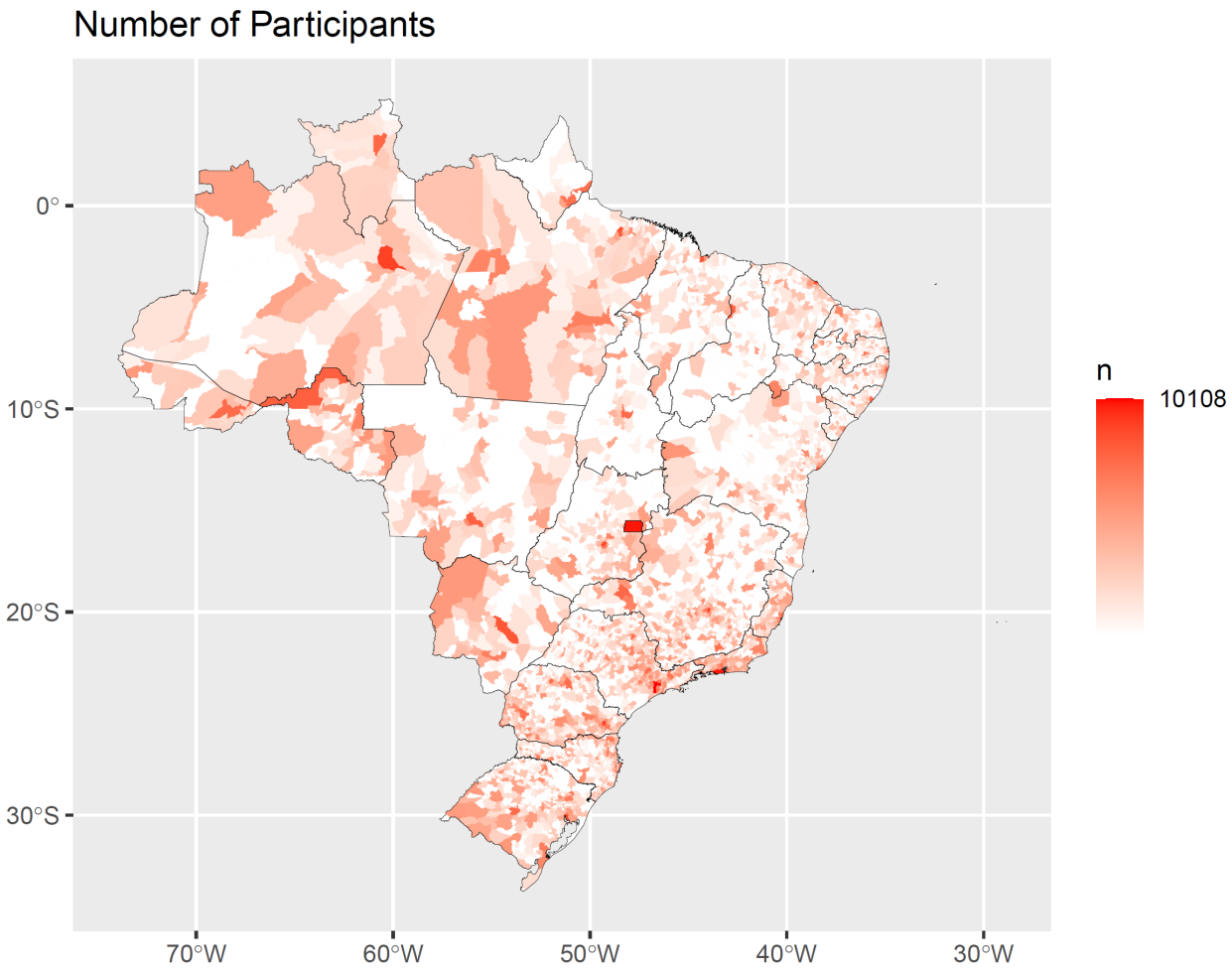
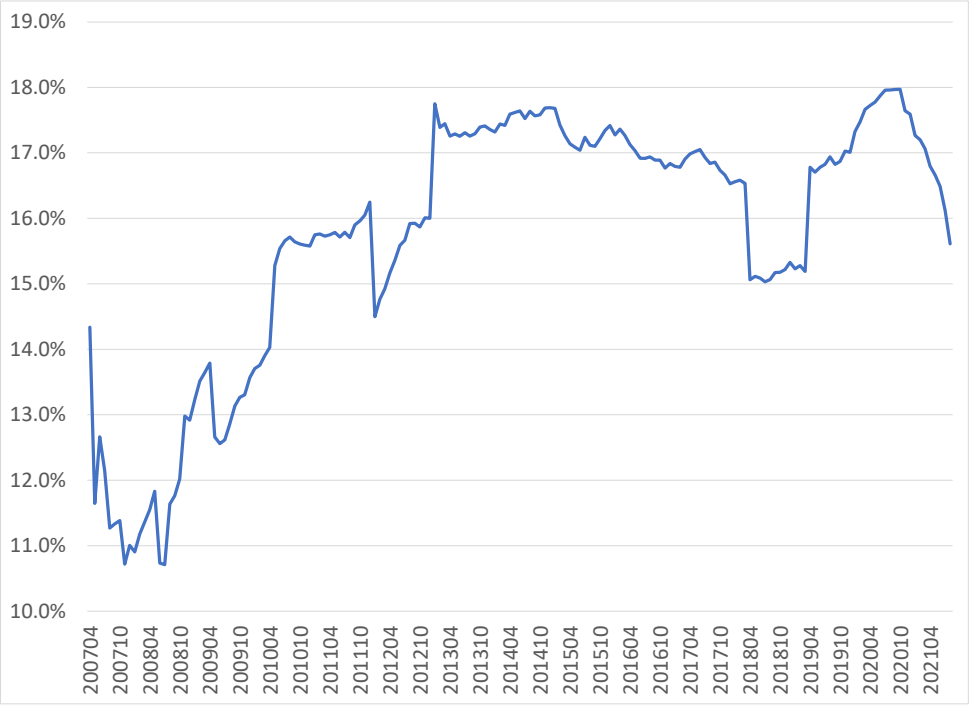
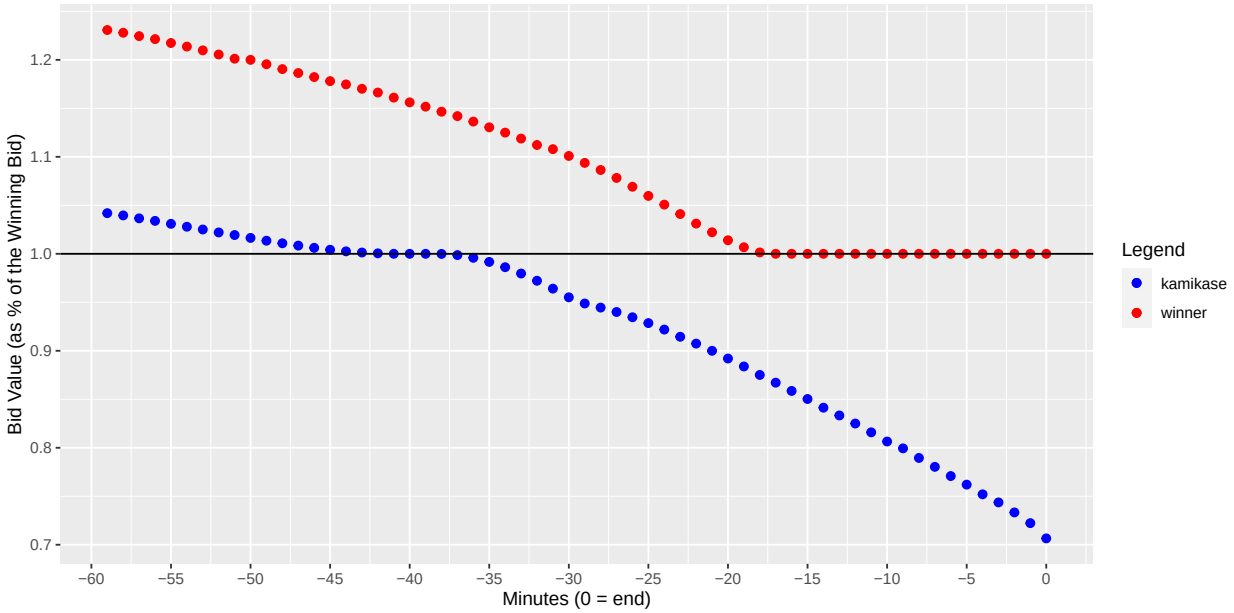

Number of Participants
0°
10°S
20°S
30°S
70°W
60°W
50°W
40°W
30°W
n
10108

Figure 3: *Prevalence of Kamikaze Strategies*



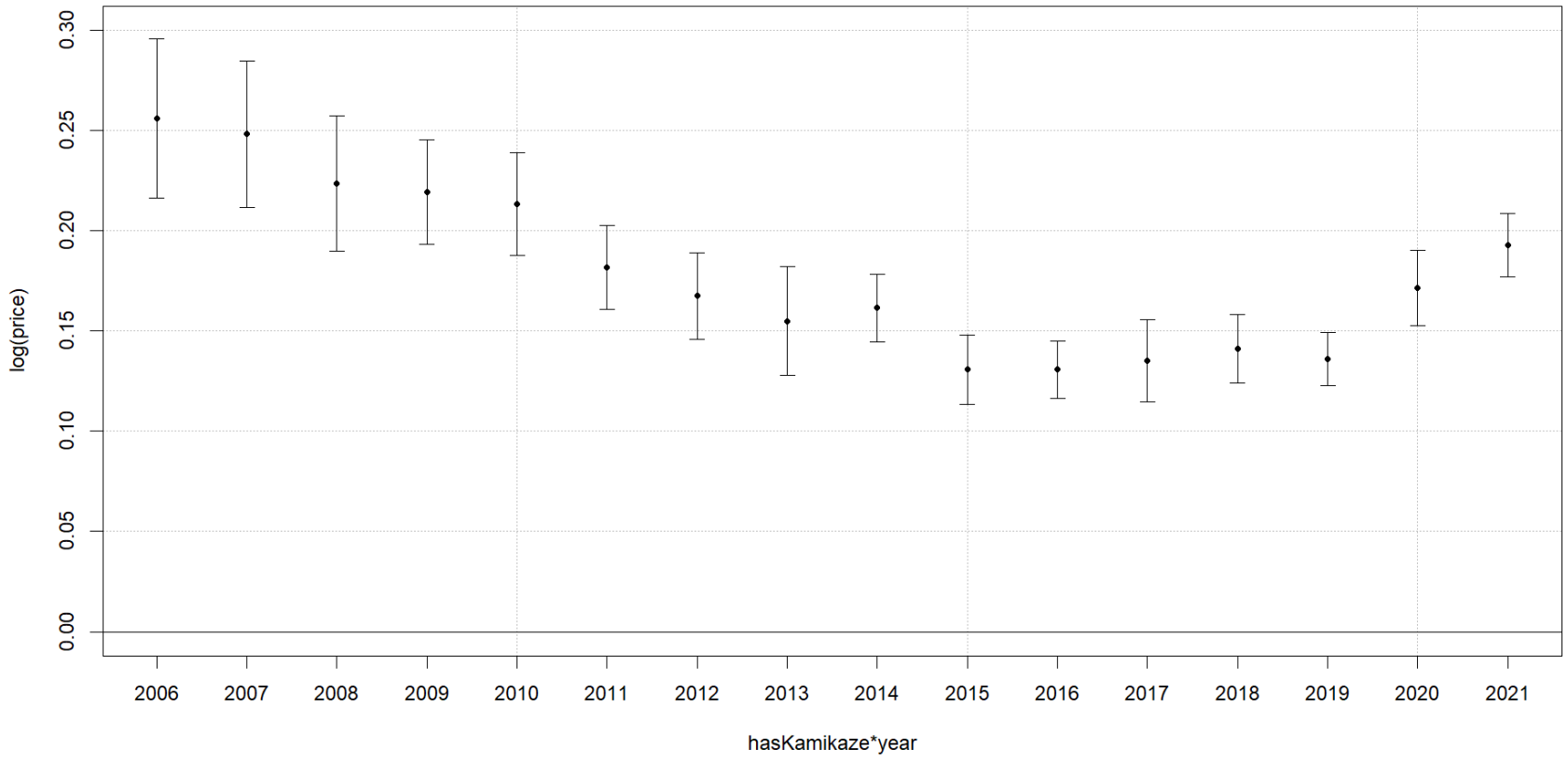
This figure shows the average fraction of auctions with kamikaze in Brazil between 2005-2021. Kamikaze firms are those that have the lowest bid but do not win the procurement because it does satisfy the final formalities to be declared the winner.

Figure 4: *Kamikaze vs Winner Bid*



This figure plots the dynamic development in minutes before the end of the auction of average bid price for kamikaze participants and the winning bidders, expressed as a % of the winning bid.

Figure 5



This figure plots the overpricing effect of kamikaze by year. We estimate equation (1) with a different coefficient for each year by interacting HasKamikaze with a year dummy.

Figure 6: *Excess Deaths in Public Hospitals*

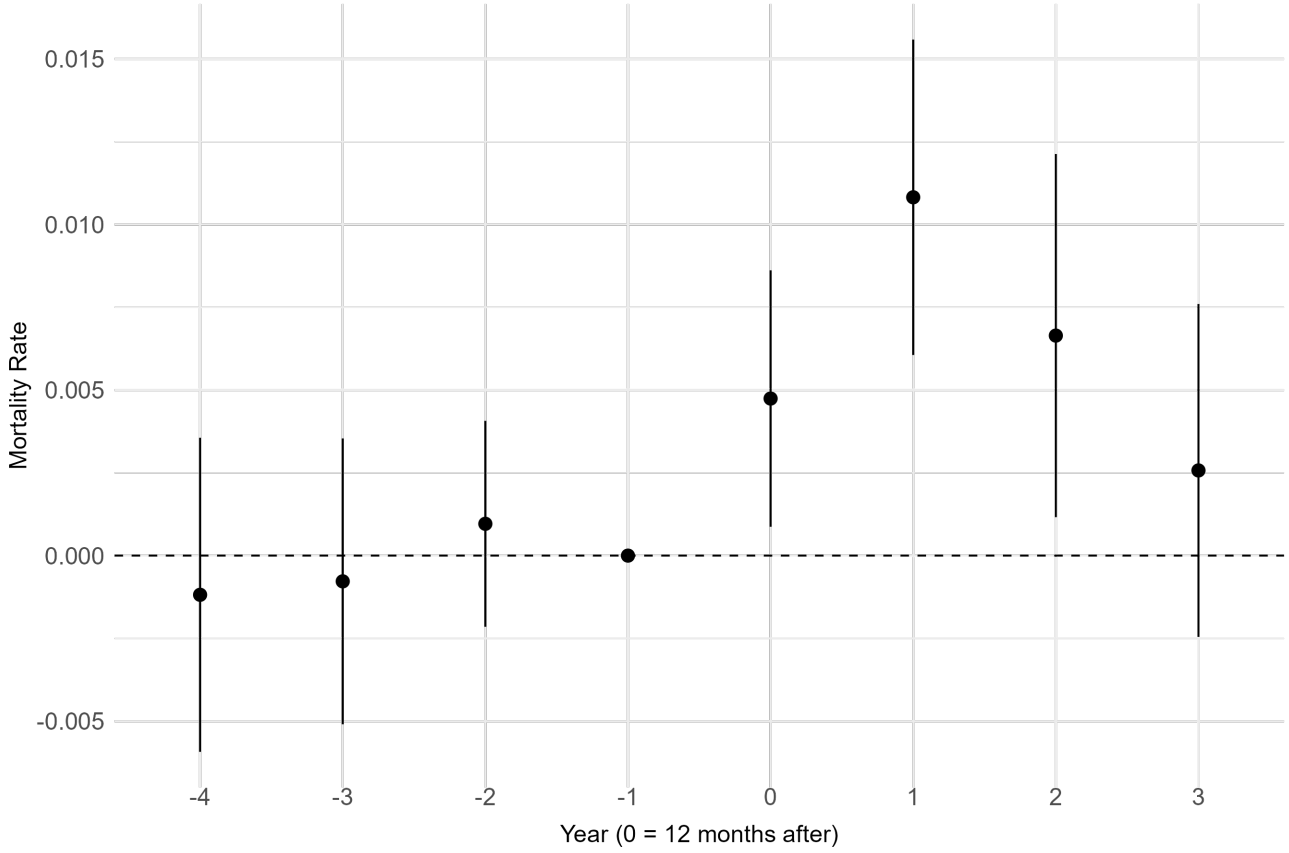
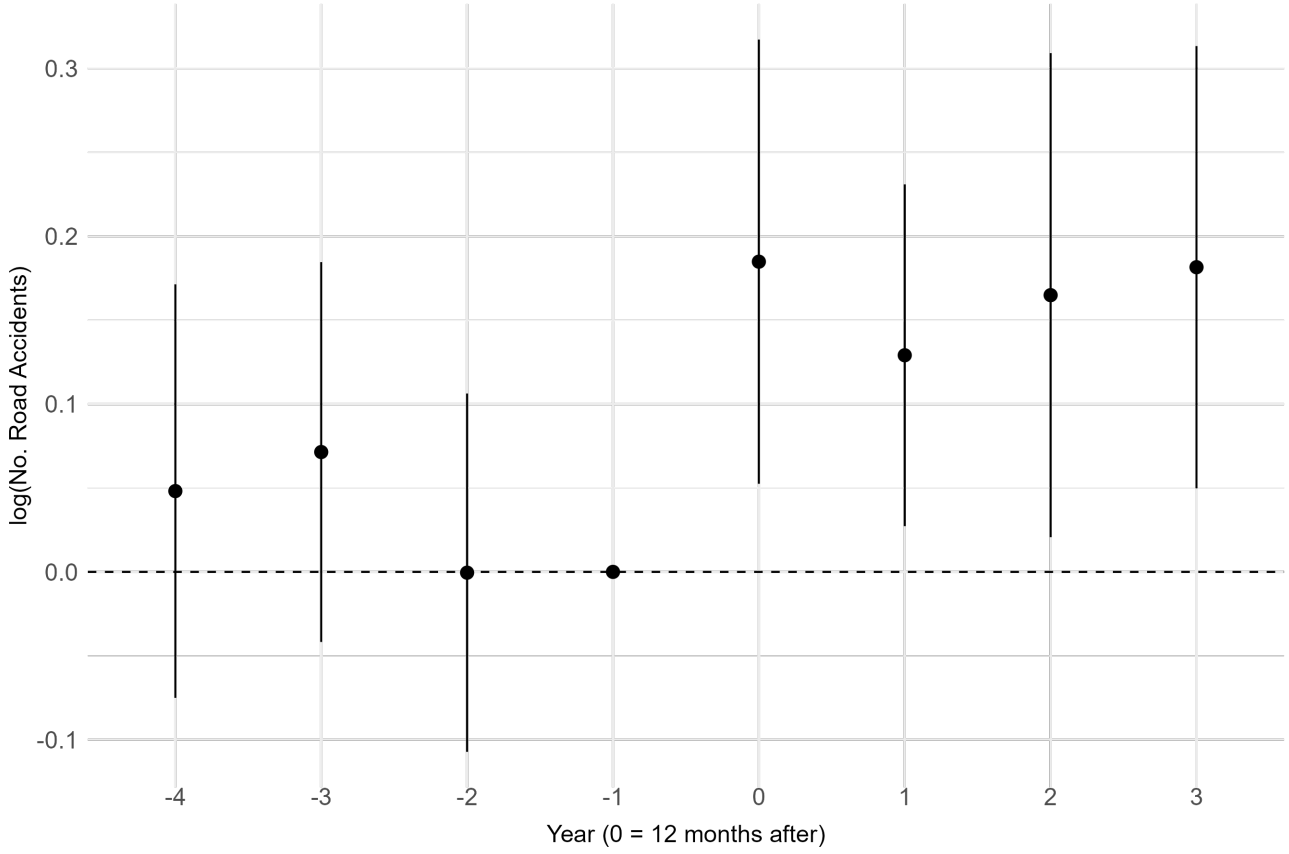


Figure 7: *Number of Road Accidents*



A Internet Appendix

Table A1: *Examples of Products and Brands*

Product		Brand
Description	Unit	
Ballpoint Pen	1 unit	Bic
Flexible Electric Cable	1 meter	Corfio
Gloves for Non-Surgical Procedure	100 units	Descarpack
Battery	1 unit	Elgin
Ethyl Alcohol	1 liter	Itaja
TV	1 unit	LG
Coffee	500 grams	Odebrecht
Coffee	1 kilogram	Pilao
External HD	1 unit	Seagate
Sugar	1 kilogram	Uniao
Mineral Water	20 liters	Villa
Detergent	500 milliliters	Ype
HP Printer Toner Cartridge	1 unit	HP
White Board Pen	1 unit	Pilot
Insulin	3 milliliters	Lantus
Microscope	1 unit	Physis
Gas	1 liter	Petrobras

Table A2: *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