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# Procuring Firm Growth: The Effects of Government Purchases on Firm Dynamics

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# Procuring Firm Growth:
## The Effects of Government Purchases on Firm Dynamics*

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**Abstract**

This paper tests whether demand shocks affect firm dynamics. We examine whether firms that win government procurement contracts grow more compared to firms that compete for these contracts but do not win. We assemble a comprehensive data set combining matched employer-employee data for the universe of formal firms in Brazil with the universe of federal government procurement contracts over the period of 2004 to 2010. Exploiting a quasi-experimental design, we find that winning at least one contract in a given quarter increases firm growth by 2.2 percentage points over that quarter, with 93% of the new hires coming from either unemployment or the informal sector. These effects also persist well beyond the length of the contracts. Part of this persistence comes from firms participating and wining more future auctions, as well as penetrating other markets.

*Keywords: Demand Shocks, Firm Productivity, Public Procurement*

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# 1 Introduction

Government purchases are used throughout the world as a tool to foster economic activity, increase employment, and encourage innovation. There is a contentious debate, however, on how effective these policies are.[1] In models with firm-level heterogeneity, the aggregate effects of government purchases depend on which firms are most affected (i.e. young versus old), how incumbent firms respond, and whether policies affect entry and exit (Acemoglu et al. (2013)). The existing empirical literature offers few insights into this question. While there is a large literature measuring the aggregate effects of government purchases, we lack evidence on how these interventions affect firm behavior at the microlevel. At some level, this is not surprising. Governments do not assign contracts at random, but instead target specific types of firms. In some cases, they may target the most productive firms when picking winners; or the less productive firms when political favoritism and corruption become a consideration. Thus, winning a government contract is likely to be correlated with unobserved firm characteristics, which makes it difficult to isolate the effects of government contracts on firm performance.

In this paper we use a new empirical strategy to assess the effects of government purchases on firm growth. We examine whether firms that win government procurement contracts in Brazil grow more compared to firms that compete for these contracts, but win less. To address the endogeneity of winning government contracts, we assemble one of the most comprehensive firm-level data sets to date. We combine the universe of procurement contracts auctioned out by Brazil's federal government over the internet during the period of 2005 to 2010 with matched employer-employee data for the universe of formal firms in Brazil.[2] From the procurement data, we observe not only the characteristics of the auction such as the product codes and the location of the auction, but also the entire distribution of bids. From the firm data, we observe firm size, age of the firm, the characteristics of all workers, and the exact date workers are hired and fired. We combine these datasets to estimate the effects of winning government contracts on firm growth for over 47,000 firms that participated in over 6.5 million lots auctioned off by Brazil's federal government during this period.[3]

[1] See for example Ramey (2011) on the evidence of fiscal multiplier. See Aghion et al. (2012) for a discussion of industrial policies.

[2] Starting in 2005, bidding on all federal procurement contracts had to be done via an Internet portal, called *ComprasNet*.

[3] A significant share of government purchases around the world is done through public procurement.

To identify the effects of winning a government contract on firm growth we introduce a novel research design that exploits three unique aspects of our setting. First, because we observe the timing and entire distribution of firms' bids in these electronic procurement auctions we can compare winners and runner-ups in very close auctions. These are auctions in which at least two firms bid in the last 30 seconds and the winning bid and the second-place bid is only a tiny fraction of the contract amount (e.g. in many auctions the difference is less than 0.001 percent). Second, unlike most auctions that end at a predetermined time (or based on a predetermined rule), the auctions carried out by Brazil's federal government end unexpectedly based on an unknown random number drawn by a computer. Neither firms nor the auctioneer know when exactly the auction will end. Third, these auctions do not contain a proxy-bidding system. Instead, firms must enter their bids manually and will routinely outbid each other several times until the auction ends at random. We show that winning these types of close auctions can be considered as good as random and that firms that lose can be used as a valid counterfactual for firms that win. We then use the contracts won by a firm within a quarter as an exogenous demand shock to the firm.

We find that winning a government contract has a significant effect on firm growth both during the quarter in which they win, as well as over the medium horizon. These effects are also larger for younger firms, conditional on size. Our estimates imply that winning at least one contract in a given quarter increases firm growth by a sizable 2.2 percentage points over the quarter, which is sufficient to move a firm located at the median of the firm growth distribution to the $75^{th}$ percentile of the distribution. These effects persist over time as firms experience growth for at least 2 years after winning a contract, which is well beyond the time when most government contracts have expired.[4]

To further understand the long-lasting effects of government contracts, we use auction and firm level data to examine the behavior of firms that were close winners and close losers. We find that these persistence effects are, in part, attributed to firm behavior in future auctions. Firms that win a close auction participate in 30 percent more auctions over the next three months compared to those firms that barely lose. Moreover a year later, we still find that close winners participate in 20 percent more auctions than close losers over a 30 day window. These participation effects translate into higher win rates, and sig-

Among OECD countries, for example, governments spend on average 13 percent of their GDP on public procurement. See Dimitri et al. (2011) on the importance of procurement around the world.

[4]The government contracts we consider typically last for a year.

nificantly more contract winnings.[5] We also find that winning a close auction affects the markets firms enter and the products they supply. Winners are more likely to participate in auctions where the buyer is located outside of their municipality and increase the number of products they compete for in auctions. These diversification effects are present both in the short and long run. Thus our findings suggest that winning government contracts through auctions increase firm growth not only because firms are more likely to get more contracts in the future, but also because they enter more valuable auctions, penetrate more markets, and also increase the variety of products they sell.

An important feature of our employer-employee dataset is that we can follow workers over time as they switch firms or enter in and out of the formal sector. This aspect of our data allows us to decompose the firm growth into hirings and firings and further examine whether the workers that are hired come from other firms or from unemployment or the informal sector. We find that 93 percent of the growth in new hires comes from individuals who were either unemployed, in the informal sector, or outside the labor force. Thus, our results show that government contracts create new formal sector jobs, and do not simply induce a reallocation of workers across firms in a given locality.

Our study is related to two strands of literature. First, we contribute to a nascent literature that examines the role demand factors play in firm growth. Our findings are consistent with those of Pozzi and Schivardi (2012) and Foster et al. (2012), who highlight the importance of demand factors and shocks in explaining firm dynamics. In contrast to our approach, much of this empirical literature has had to rely on the availability of price data and functional form assumptions in order to disentangle demand from productivity shocks (Pozzi and Schivardi (2012), Foster et al. (2012), De Loecker (2011)). Besides our study, the only other exception is Atkin et al. (2014) who conduct a randomized control trial that generates exogenous variation in the access to foreign markets for Egyptian firms. They document that, after starting to export, firms increase the quality of products through learning from their foreign buyers. Thus, they also provide evidence consistent with the importance of demand constraints and the effects of relaxing those constraints through expanding market access.

Second, our findings relate to an extensive literature that examines the life cycle of firms (e.g. Sutton (1997)). As the literature has pointed out, firms tend to grow as they age,

[5] These results are consistent with a learning-by-doing process highlighted by Jofre-Bonet and Pesendorfer (2003) and Tiererova (2013).

and this life-cycle pattern is often interpreted as evidence of firm-specific accumulation of organizational capital (Atkeson and Kehoe (2005); Hsieh and Klenow (2014), Kueng et al. (2014)). Growth in organizational capital can come about due to investments in new technologies, managerial practices, or customer capital.[6] If younger firms have not yet developed this organization capital and do not, for instance, have the customer base of older firms, then we would expect the effects of these government-induced demand shocks to be more pronounced among younger firms. This is precisely what we find. The effects for firms less than 5 years old are twice the size of the effects for firms between 5 and 15 years old, and more than 4 times the effects size among firms 25 years and older.[7]

The plan for the paper is as follows. The next section offers some background on Brazil's public procurement auction, followed by Section 3, which describes our research design and tests of its validity. Section 4 discusses our dataset and estimation sample, and we present our results in Section 5. Section 6 concludes.

# 2 Background

In this section, we provide a brief description of public procurement auctions in Brazil. We then highlight two features of the auction process that are central to our empirical strategy – the random ending of auctions and the absence of proxy bidding.

## 2.1 Electronic Procurement Auctions in Brazil

The Brazilian public administration has used reverse auctions as a procurement method for off-the-shelf goods – from pharmaceuticals to cleaning services – since 2001.[8] Starting in 2005, it became mandatory for federal agencies to procure off-the-shelf goods through

[6] See for example Cabral and Mata (2003), Rob and Fishman (2005), Arkolakis (2010), Dinlersoz and Yorukoglu (2012), Gourio and Rudanko (2014), Luttmer (2011), Drozd and Nosal (2012), Kueng et al. (2014).

[7] These results are consistent with Fort et al. (2013) who find that younger business in the U.S. are more sensitive to cyclical shocks.

[8] Off-the-shelf goods are goods that have precise and concise enough specifications, so that bids can be compared solely based on price. IT equipment for instance qualify as off-the-shelf, whereas engineering projects do not. Although the legislation does not provide a clear-cut definition of an "engineering project", it is known, for example, to include entire road resurfacing works. On the other hand, reverse auction are sometimes used to procure small demolition work. Federal Law 8666/93 regulates public procurement in Brazil, and Federal Law 10520/2002 are specific to procurement auctions. For a detailed description of public procurement in Brazil, see World Bank (2004).

these auctions, and to conduct them online on ComprasNet, a one-stop internet portal for the federal government's procurement of goods and services. Each year, around 2200 public bodies scattered across the country list around 1 million lots on ComprasNet; in 2012, 0.76 percent of Brazil's GDP – or R$ 33.6 billion worth of contracts accounting for 46 percent of the federal government's procurement spending – was awarded through ComprasNet auctions. In short, these auctions represent a large share of federal tenders and a substantial amount is contracted through them every year.

Over 65,000 firms have placed bids in the ComprasNet platform for contracts to supply the government with various goods and services. To participate in an auction, firms must first register as a vendor. To encourage participation, especially among small firms, the registration process which is done online is fairly streamlined and simple. And while participation in some specific auctions may involve additional requirements – for example, in the case of service contracts, a public body may ask firms to provide proof that they have the capacity to deliver the same type of service at a similar scale – most of the documents supporting a firm's bid are submitted *after* winning an auction, which again lowers the cost of participating.

A typical ComprasNet auction starts with a public body defining lots it needs to procure. A lot consists of some indivisible quantity of an off-the-shelf good or service.[9] Several lots can be procured at the same session. Next, the public body must provide a reservation price for each lot. The reservation price is calculated as the average of at least three quotes obtained through market research, and is meant to capture the retail price of the lot. Finally, the public body advertises the tender at least 8 days before the session and publishes a tender document on the internet. The tender document is free to download anonymously and contains a detailed description of each lot, the date of the session, reservation prices and the contract's terms and conditions.

## 2.2 The Auction Mechanism

Two features of ComprasNet auctions are central to our empirical strategy. First, within time limits, these auctions end at random. To explain how this random ending works, Figure 1 depicts the bidding timeline of a typical auction. Interested firms must submit a

[9] In principle, auctioneers may allow bidders to bid for fractions of the lot. In practice, this is very rarely done. In the data, we noted 724 lots (out of more than 6 million) in which two or more bidders were awarded fractions of the lot.

sealed bid before a pre-specified deadline $t_0$, after which no firm may enter the auction. At $t_0$ sealed bids are open, and bidders learn the low bid. Firms now engage in a descending auction, and can place as many new bids as they wish.[10] At a point $t_1$, the auctioneer announces $t_2$, the start of the ending (random) phase. Bidding ends at a point $t_3$ up to 30 minutes after $t_2$, but firms, as well as the auctioneer, only learn $t_3$ once it has passed. The lowest bidder at $t_3$ wins and is paid her bid. It is important to note that winning is only a function of price and not quality.[11]

To illustrate that auctions indeed end at random, Figure 2 shows the distribution of the final (random) phase duration, for two periods. Panel (a) depicts the distribution of random phases from 2004 to April 2006. In this period, the end phase duration clearly followed a uniform distribution on the $[0, 30]$ minutes interval, as mandated by the ComprasNet rules. Following complains by firms claiming that this rule did not give them enough time to place their best bids, ComprasNet changed the rules. The distribution of random phases after this change is depicted in Panel (b). This distribution results from the sum of a uniform [5,30] plus one random draw from a uniform [0,2] for each bid placed in the auction, as long as the total time does not exceed 30 minutes. If the random draw does extend the total time beyond 30 minutes, the random draw is not added, which is why the random phase can be less than 30 minutes even when there has been a sufficiently high number of bids. In sum, even though firms had more time to place their bids, they remained ex-ante ignorant about the exact time the auction ended.

A second important feature of these auctions is the absence of a proxy bidding system. Proxy bidding, available in platforms such as eBay, allows bidders to submit their reservation prices and have the system automatically place new bids on their behalf as soon as they are outbid (see, for example, Roth and Ockenfels (2002)). In contrast, every time firms wish to lower their bids in ComprasNet, they must enter it manually on the auction page, which gives rise to potential bidding frictions. Given the setup of the online marketplace, it takes firms a minimum of 6 seconds to submit a bid. Note also that there is no

[10] A bidder can only place bids strictly lower than her own previous bids. Bidders can, however, submit bids higher than other bidders' previous bids. This is to avoid a situation in which typos (unintentional or otherwise) prevent bidders from placing new bids. The platform software uses an algorithm to spot this sort of typos.

[11] After bidding closes, the auctioneer checks if the best bid is below the reservation price. If it is, the best bidder is requested to submit supporting documentation. Required documents vary across lots, but are described in the tender announcement. Documents typically concern firms' tax duties, but may include, for example, a cost breakdown when the lot is a service, or sample items if the lot is a good. If the documentation is accepted, the lot is adjudicated.

minimum bid decrement[12], and throughout the auction firms (and the auctioneer) only learn the currently low bid, but neither the identity of the firms nor the history of bids.

# 3 Empirical Strategy

We are interested in estimating the effect of winning a government contract on firm growth. Let the growth rate of firm $i$ in period $t$ be given by $g_{it}$. We can write the growth of firm $i$ as:

$$g_{it} = f(X_{it}, U_i, D_{it}, \varepsilon_{it}) \tag{1}$$

where $X_{it}$ represent firm observable characteristics, $U_i$ represent firm unobservable characteristics, $D_{it}$ represents the demand for the firm's products (firm sales or purchased orders) received in period $t$, and $\varepsilon_{it}$ represents shocks to firm growth in period $t$ that are not observed to the econometrician (e.g. changes in firm productivity).

If we assume an additive and linear model, we could estimate a reduced-form equation for the growth of firms as:

$$g_{it} = \beta_0 + \beta_1 D_{it} + \delta X_{it} + \epsilon_{it} \tag{2}$$

where the error term $\epsilon_{it} = U_i + \varepsilon_{it}$ is composed of a fixed firm-level unobservable characteristic and a component that varies over time.

Our measure of purchase orders or demand $D_{it}$ can be further separated into purchase orders that come from the private sector, $P_{it}$, and orders that come from the government, $G_{it}$: $D_{it} = G_{it} + P_{it}$. Because we only observe purchase orders that come from the government, all purchase orders from the private sector will be part of the unobserved component of firm growth: $\epsilon_{it} = U_i + P_{it} + \varepsilon_{it}$.

In this setting, there are two potential sources of bias from estimating Equation 2 by OLS. First, because we only observe purchase orders from the government, any correlation between private and government sales will bias our coefficient. If private sector contracts crowd-out government contracts due to perhaps capacity constraints, then we will underestimate the effects of government contracts on firm growth. Similarly, if negative demand shocks in the private sector induce firms to participate more in government auctions, then this too will bias our coefficient downwards. A second source of bias arises if government

[12]To be precise, the minimum bid decrement is R$0.01, which is negligible.

contracts are awarded to the most productive firms. In this case, firms who receive positive productivity shocks will not only be more likely to win a government contract, but will also tend to grow more (independently of winning the contract). This of course will lead us to over-estimate the coefficient of interest.

To overcome these estimation concerns, we propose a novel empirical strategy that exploits the unique design of the procurement auctions to construct an exogenous demand shock. We then use this government-induced demand shock as an instrument to estimate the effects of winning government contracts on firm dynamics. We describe the approach next.

## 3.1 Research Design with Close Auctions

We define a close auction as any auction in which both the winner and loser placed a bid within the last 30 seconds of the auction, and the win margin was less 0.5%. The use of close auctions combined with the random ending are critical features of our research design. To see why, consider the following simple example. Suppose there are two types of firms: high-valuation firms and low-valuation firms. This will generate three types of auctions: 1) two high-valuation firms are competing; 2) two low valuation-firms are competing; and 3) a high-valuation firm competes against a low-valuation firm. For the first two types of auctions, the losing firms will on average serve as a good counterfactual for the winning firms when we restrict our sample to auctions that ended with a close win margin. The potentially problematic comparison lies with the third set of auctions. In these auctions, the high-valuation firm can engage in two strategies. First, the high valuation firm may decide to aggressively bid its true (or near its true) valuation, and win with probability one. In this case, the difference in bids between the first and second place bids is likely to be large, or the auction is resolved early on. By considering small win margins and tight timings, we eliminate these auctions from our identifying variation. Alternatively, instead of bidding its true valuation, the high-valuation firm may chose to place a lower initial bid and only increase its bid by an small incremental amount if the low-valuation firm outbids the current offer. This is a riskier strategy given the auction's random ending and possible frictions in the bidding technology. As a result of the random ending, high valuation firms engaged in this strategy will win in some cases but lose in others. Thus, in expectation, the winners and losers of these types of auctions will be similar.

This intuition is formalized in Szerman (2012), which extends the Ockenfels and Roth (2006) model of eBay auctions to allow for a random ending rule.[13] This model generates two types of equilibria. The first is one in which all bidders bid up to their true valuations before the random phase starts. These equilibria are payoff equivalent to the standard equilibrium in weakly dominant strategies of a Vickrey auction. Once the random phase starts, there is no further bidding and the firm with the highest valuation wins. This type of equilibria are not part of our close auctions.

The second type of equilibria is where firms engage in an incremental bidding strategy during the random phase of the auction. The key element for late bidding to arise in equilibrium is that there exists some probability that bids are not transmitted towards the end of the auction due to bidding frictions. When some bids are not transmitted, the winning price is effectively higher, causing expected surplus to be transferred from the auctioneer to bidders. As a result, bidders will avoid an early price war and engage in incremental bidding during the random phase.[14] This is the bidding behavior that gives rise to the close auctions we use.

Given our research design and the structure of the auction data, it would be natural to estimate the following model:

$$y_{i,k+t} = \alpha + \tau[1|W_{i,k} > 0] + f(W_{ik}) + \delta_k + \varepsilon_{ik} \tag{3}$$

where $y_{i,k+t}$ is the outcome of firm $i$ at time $t$ periods after auction $k$, $W_{ik}$ is the win margin of firm $i$ in auction $k$ and $\tau$ measures the causal effect of winning an auction on outcome $y_{i,k+t}$. The function $f(W_{ik})$ is a smooth function of the win margin and $\delta_k$ are a set of auction fixed effects so as to exploit within auction variation.

Although we estimate this specification for auction-level outcomes, it poses two practical problems for estimating the effects of winning a contract on firm dynamics. First, firm size is unlikely to change at the daily level. For meaningful variation in firm size, our unit of time needs to be longer. Second, firms will enter and win several auctions within a single day. In this case, how much a firm wins in an average auction is less relevant to a firm's employment decisions than how much it won in total over a given period of

[13] See Appendix A for a formal treatment of the model.

[14] Szerman (2012) show that such equilibrium can be sustained with a likelihood that is non-monotonic on the probability that bids do not get transmitted: if the probability is too low, then there is little to be gained by delaying bidding. On the other hand if the probability is too high, then the chances of winning the auction are too low.

time. For these reasons, we examine firm growth at the quarterly level, which requires an alternative identification strategy.

To identify the causal relationship of the amount of contracts a firm wins on firm growth, we exploit variation in the share of close auctions won by a firm in a given quarter. Firms typically participate in several auctions in a given quarter, and some of those will end up being close auctions. Because there is a random component of who wins the close-auctions due to the random-ending auction design, the outcome of many of these auctions ends up being as good as random, conditional on firms participating in these auctions. Thus, the proportion of close-auctions won during a quarter provides us with exogenous variation in the total amount that a firm won.[15] Using this variation, we can measure the causal effects by estimating the following model by TSLS:

$$g_{it} = \alpha \hat{G}_{it} + \eta_i + \delta_t + \epsilon_{it} \quad (4)$$

$$G_{it} = \gamma Z_{it} + \xi_i + \kappa_t + \nu_{it} \quad (5)$$

where $g_{it}$ is the growth in employment in period $t$ for firm $i$, $G_{it}$ is the total value of government contracts won by firm $i$ in period $t$, $Z_{it}$ is the total value of contracts won in close auctions by firm $i$ in period $t$ divided by the total value of contracts from auctions that firm $i$ participated in that period, i.e. $Z_{it} = V_{it}^{\text{win close}} / (V_{it}^{\text{lose close}} + V_{it}^{\text{win close}})$.[16] $\eta_i, \xi_i$ and $\delta_t, \kappa_t$ are firm and time fixed-effects. The estimate of $\alpha$ yields the causal effect of a government-induced demand on firm growth conditional on participation.[17]

## 3.2 Adjusting for Endogenous Participation

As we discuss in Section 4, our estimation sample only includes firms who have ever participated in a government auction. But even within this restricted sample, in any given period a firm will choose whether or not to participate in a set of auctions, which creates a potential sample selection issue when estimating Equation 4. We account for this endoge-

[15] This approach is similar to the one used by Rehavi (2007) to assess the effects of female legislators on public spending.

[16] Following Bartelsman et al. (2013), we calculate firm growth $g_{it} = (E_{it} - E_{it-1}) / (0.5 \times E_{it} + 0.5 \times E_{it-1})$ to account for the fact that firms can have zero employees in some periods.

[17] Note that for the exclusion restriction to hold, we need to assume that private sector sales at time $t$ do not respond to the unexpected shocks also occurring at time $t$. We think this is a reasonable assumption given that investments into private sector sales are likely to occur prior to or at the beginning of the quarter. Violations to this assumption are likely to produce underestimates of the true effect.

nous participation decision following the selection procedure suggested by Semykina and Wooldridge (2010). We proceed in two steps: first, we estimate the probability that a firm participates in a government auction in a particular quarter. Let $s_{it}^*$ denote the latent variable determining participation, which we model as follows:

$$s_{it}^* = \beta Z_{it-1} + \eta_i + \delta_t + v_{it}.$$

Here $v_{it}$ is an idiosyncratic error term, $Z_{it-1}$ is our demand shock in the previous period. The selection indicator $s_{it}$ can be defined as:

$$s_{it} = 1[s_{it}^* > 0] = 1[\beta Z_{it-1} + \eta_i + \delta_t + v_{it} > 0], \tag{6}$$

where $1[\cdot]$ represents the indicator function. Under the assumption that $v_{it}$ is $N(0,1)$, we can estimate Equation 6 as a probit model. The key identifying assumption underlying this estimation is the exogeneity of the demand shock in the previous period, which as we will show below, strongly predicts participation in future auctions. Based on the estimation of this selection equation, we then compute an inverse Mills Ratio, $\lambda_{it}$. In the second step, we re-estimate Equation 4 with the addition of the inverse Mills Ratio for the selected sample.

The validity of this approach hinges on two related assumptions: 1) $Z_{it-1}$ is exogenous to the selection equation, and 2) $Z_{it-1}$ does not directly affect growth in period $t$. Both assumptions are quite plausible. Given our research design, $Z_{it}$ is exogenous for all $t$ and as we will document in Section 5 winning a close auction in period $t$ induces firms to participate in auctions in the next period. The plausibility of the second assumption is more subtle. Conditional on our model specification being correct, and in particular the lag structure governing $G_{it}$, $Z_{it-1}$ should not directly affect firm growth. Of course, if the true growth model was determined by both $G_{it}$ and $G_{it-1}$, then by not controlling for government sales in the previous period, we would be creating an artificial correlation between $\varepsilon_{it}$ and $Z_{it-1}$ and our exclusion restriction would not hold. Although in this case, we could in principal then use $Z_{it-2}$ as an instrument in the selection model.

# 4 Data

To estimate the effects of winning a procurement contract on firm dynamics, we assemble an original data set that combines data on the universe of federal procurement auctions from 2004 to 2010 with data on the universe of formal firms in Brazil. In this section, we describe these data, and our final estimation sample.

## 4.1 Online Procurement Data

We use data on over 4.2 million lots auctioned off by federal public bodies between 2004 and 2010 through ComprasNet. Our data come from two administrative sources. First, we use publicly available data from ComprasNet. For each lot, the ComprasNet platform automatically records the following information: the reservation price; the name and tax revenue number of firms participating in the auction; all bids placed by each firm and their respective time stamps; time stamps for each auction event (as depicted in Figure 1); and the purchasing unit running the auction. All this information is recorded and published in html format at the ComprasNet website.[18] We extract this information from the web pages to construct our data set.

Second, we complement these data with internal data from the Ministry of Planning, Budget and Management. These data contain information on lots, bidders, and purchasing units. On lots, there is a paragraph-long description of the item along with product classification codes following the United States' Federal Supply Codes (FSC) for materials and United Nations' Central Product Classification for services. These classification schemes define product categories by 2-digit codes, and sub-categories by 4-digit codes[19]. On bidders, the data contain information on whether they are registered as a small or micro enterprise (SME). Finally, these data contains the municipality and state of the purchasing units. These two sources are combined to form a dataset in which each auction is an observation.

Table 1 reports statistics for the 20 most frequent product categories in the sample. As the categories header suggests, various types of goods and services from different industries are procured through ComprasNet auctions. Categories range from books, to pharmaceu-

[18] See http://www.comprasgovernamentais.gov.br/

[19] The Federal Supply Codes are available at http://www.dlis.dla.mil/H2/search.aspx.

tical, to building materials. Moreover, items auctioned are primarily retail goods; only one service category (Maintenance & Installation Services) makes it into the top 20. Overall, services make up less than 5 percent of the number of lots (not shown in the table), and as a result we exclude them from the main analysis. Columns 1 and 2 give the total and relative frequencies of each category. The top 6 categories account for more than 50 percent of the total number of lots. Overall it is worth emphasizing that we are considering contracts for the procurement of off-the-shelf goods, as opposed to large-scale construction projects.

Table 2 presents descriptive statistics for our sample of auctions and close auctions. The reservation value of each lot is on average R$18,155. The winning bid ends up being around 69 percent of the reservation price, with the difference between the winning bid and the second place bid being around 10 percent. On average 7 bidders participate for each lot. Of these 7 bidders, only two are from the same city in which the public body is located, which again highlights the important role this procurement system plays in providing firms with access to other markets. The auctions are held throughout Brazil, with a slight concentration in the Southeast region of the country. When we restrict the sample to close auctions, we see unsurprisingly that the reservation price is 64 percent higher compared to the overall sample and that the winning bid is 71 percent of the reservation price. Naturally, these lots attracted more bidders, with an average of 8.44 bidders.

Bidding in this marketplace is quite active, particularly in close auctions. On average there are 81.4 bids in close auctions, with 92.5 percent of those bids occurring during the random phase. In the end, winners place slightly more bids than the second-place firms, but this isn't surprising given that winners by definition will have always placed the last bid. For close auctions, winners take on average 18.1 seconds in between bids during the random phase of the auction, compared to 21.6 seconds for the second-place firms. This small difference is not only below the 6 seconds it would take a firm to submit a bid, but part of the difference is again mechanical since winners have the advantage of having had placed the last bid. Also, neither winners nor runner-ups necessarily start off with aggressive opening bids. On average both winners and runner-ups place opening bids that ranked them in between $3^{rd}$ and $4^{th}$. Overall, we find no evidence that winners and runner ups in close auctions are engaging in different bidding strategies, which is important for our research design.

## 4.2 Firm-Level Data

We use matched employer-employee data from the *Relação Anual de Informações Sociais* (RAIS) during the period of 2003-2010.The RAIS is an administrative data set collected on an annual basis by the Brazilian Ministry of Labor. It covers all (formal) firms and workers in Brazil, and contains information on wages, education, gender, and age of every employee in all firms. At the end of each year, firms give a monthly breakdown of the status of each of their employees, including the month that they were hired and fired. We construct quarterly measures of firm growth in terms of number of employees. Furthermore, we have firms' geographical locations and industry, as defined by the International Standard Industrial Classification (ISIC). Firms are identified by their tax revenue number, which allows us to match these data with the ComprasNet auction data. Our final estimation sample only includes those firms that appear in the RAIS and have participated in a federal public procurement auction.

Table 3 presents descriptive statistics for the firms in our data, as well as for the entire firm population. As we see from the table, the sample of firms who participate in the public procurement auctions are larger, and pay slightly higher hourly wages. Firms in our sample have an average number of 28.2 employees and offer an hourly wage of $20.7, compared to an average firm size of 11.5 and an hourly wage of $18 for the entire sample. Firms in our sample also experienced a quarterly growth of 2.1 percent during the period, compared to only 1.5 percent for the sample as a whole. The majority of the workforce consists of permanent workers: Only 0.43 out 28.2 employees are classified as temporary workers.

On average, firms hire 3.64 new employees per quarter. Most of these new employees come from either unemployment or from the informal sector: Only 0.77 of a new employee comes from other firms. As documented by Gonzaga (2003) and others, the worker turnover rates in Brazil are some of the highest in the world. In addition to the new hires, firms also layoff 3.11 workers per quarter.

From Table 3, we also see that on average firms participate in over 31 auctions per quarter, winning on average 4.8, which amounts to an average BRL $183,200 per quarter. Considering that the average monthly wage bill of the firm is BRL $164,100, these winnings are a sizable source of revenue to the firm.

The average age of the firms in our sample is 7 years. In Figure 3 we plot the share of

employment by the age of the firm. Forty percent of formal sector employment comes from firms that are below the age of 15. This number is between those documented for Mexico ($\tilde{6}0\%$) and US ($\tilde{3}0\%$). In Brazil, less than 27 percent of the formal sector is employed by firms over the age of 29, whereas in the U.S. almost 40 percent are employed by these older firms (Hsieh and Klenow (2014)).

In Figure 4, we plot the relationship between firm size and age of the firm, distinguishing between firms that are located in municipalities below the median in per capita GDP and those located above the median. The difference in the life-cycle of these two sets of firms is quite striking and consistent with the patterns documented across countries. For firms below the age of 15, the relationship between firm size and age is very similar for firms located in poorer municipalities compared to those located in richer municipalities. But for firms 15 years old and older, there is a pronounced divergence. Among these older firms, the relationship is much flatter for firms located in poorer municipalities. For example, among firms 30 years old and older, firms located in richer municipalities are more than 2.5 times larger than firms located in poorer regions. These stylized facts serve as part of the motivation for investigating whether the effects of demand shocks vary according to the age of the firm.

Combining these two datasets, our final estimation sample consists of every firm that ever participated in at least one federal auction during the period of 2004-2010.

## 4.3 Validity of the Close-Auction Design

For our preferred specification, we define a close auction as one in which at least two firms issue bids within the last 30 seconds of the auction ending, and the difference between the winning and losing bids is less than 0.05% of the second-place bid. This definition, while somewhat arbitrary, trades off the usual bias versus efficiency concerns that has become common to regression discontinuity designs. Our results (as we document below) are, however, highly robust to both relaxing and restricting this definition.

Given this definition, the validity of our instrument depends on whether winning close auctions can be treated as random events. Our implicit assumption is that firms who barely win an auction are similar, on average, to those that barely lose an auction. Several features of the auction suggest that this likely to be a reasonable assumption. As we discussed in Section 2, the duration of the auction is a random event. Thus, firms do not

know when the auction will end, and moreover throughout the auction, both firms and the auctioneer only observe the current low bid: neither the identity of the bidding firm nor the history of bids are ever revealed. Also firms do not benefit from a proxy-bidding system, and must enter their bids manually. As we restrict the sample to firms who were issuing similar bids just prior to the auction's end, it is likely that firms that barely win and barely lose are similar in their productive characteristics, on average.

In Table 4, we provide further evidence that firms who barely lose are in fact similar to firms that barely win for various definitions of closeness. In the top panel, we restrict the sample to auctions with at least 2 active bidders in the last 30 seconds, and where the bid difference between the first and second-place bidders is less than 0.5 percent. Approximately 265,000 auctions satisfy this definition of closeness, and we will use this definition for the rest of analysis. Based on this sample, first and second-place firms are similar along several key characteristics, such as their growth rate in both the previous quarter as well as the previous 12 months, win rates, number of employees, etc. Only the average real wage in the previous quarter is statistically significant at a 10 percent level.

In the remaining two panels of Table 4 we strengthen our definition of closeness along two dimensions. In the middle panel, we reduced the sample used in the top panel to include only auctions with at least 2 active bidders in the last 12 seconds. Whereas in the bottom panel, we restrict the sample used in the top panel to auctions, in which the difference between the first and second place bidders is less than 0.1 percent. For the middle panel, we see that the differences between the first and second place firms decrease along some characteristics, but increase along others. For instance, while there is no longer a difference in average real wage in the previous quarter, there are significant differences in the number of employees in the previous quarter and whether the bidder is registered as a small-medium enterprise. Our third definition of closeness (presented in the bottom panel) does not necessarily achieve more balance, despite a stricter requirement for differences in the bid amounts. Overall for our definition of closeness the results suggest that the characteristics of first and second-placed firms are well balanced.

As a further validity check of our research design, in Table 5 we compute for our sample of close auctions, the proportion of auctions the winning and losing firms would win if the auction had ended at an earlier point in time. Given the random-ending rule and the frictions in the bidding technology that don't allow firms to bid faster than every 6 seconds, we would expect the identity of the winners and losers to switch back and forth

as we "end" the auction at earlier points in time. This is precisely what we see in Table 5. In row 1 we computed the proportion of auctions the winning firm would have won had the auction ended 6 seconds before its actual ending time. In column 2 of the same row, we compute the proportion of auctions the losing firm would have won. The sample used in columns 1 and 2 is based on our preferred definition of a close auction.

When we end the auction 6 seconds prior to actual end time, we see that actual winning firm would have won 50 percent of time, which is expected since the winning firm was the last one to bid by definition. Had the auction ended 12 seconds earlier, the runner-up firm would have won 48 percent of the time compared to only 40 percent of the time for the winning firm.[20] The identity of the winning firm then switch back when we look at the 18 second mark. This pattern is consistent with the idea that as firms outbid each other, it is the random end time of the auction that ultimately determines which firm wins.

We also test for any discontinuous breaks in distribution of bids near the threshold. A common concern that arises with such a design is the potential manipulation of the running variable, or in our case the bids. For instance, if the auctioneer could manipulate the bidding system, then we might expect to observe a concentration of bids that barely win. The distribution of bids is however quite continuous, which is not surprising given that the random-duration feature of the auctions was implemented in part as a safeguard against corruption.[21]

# 5 Results

We begin this section by documenting the effects of winning government contracts on firm growth, both in the short and medium run, and find that these effects persist well beyond the length of an average government contract. We then use data at the auction level to investigate the mechanisms that lead to this persistence. Here, we show that winning a contract affects how firms behave in future auctions, which we interpret as evidence of learning. We conclude this section by showing that most of the effects on firm growth come from firms hiring workers out of unemployment or the informal sector.

[20] Since other firms may also be participating in the auctions, these percentages need not sum up to one.

[21] We do not report these results in order to economize on space. They can be made available upon request.

## 5.1 The Effects of Winning Government Contracts on Firm Growth

Table 6 presents the effect of winning government contracts on firm growth. The unit of observation in all specifications is a firm-quarter pair and we control for both firm and time-fixed effects. To account for any serial correlation across firms, we cluster our standard errors at the firm level. We use two different measures of government contracts: an indicator for whether the firm won at least one contract during that quarter and the total value of contracts won. On average 15 percent of the firms win at least one contract in a given quarter and conditional on winning a contract, the average winnings for a firm is a sizable BRL$1.3 million.

In columns 1 and 2 we present the OLS estimates. Winning a contract increases firm growth in that quarter by 1 percentage point, from a baseline growth rate of 2.4 percent (see column 1). In column 2, we present the results using the total value of contracts won by the firm in a quarter. Based on our estimates, a 10 percent increase in the value of contracts won increases firm growth by 0.01 percentage points, or 0.45 percent over the baseline growth rate.

Overall these effects are fairly modest, but as we discussed in Section 3, interpreting these estimates as causal can be problematic. Although the OLS estimates do account for unobserved firm characteristics that are fixed over time, productivity shocks or demand shocks to the firm arising from the private sector can potentially bias these estimates. To overcome these sources of bias, we present in columns 3-8 results that rely on the variation in contract winnings from close auctions.

In columns 3 and 4, we present reduced-form estimates, using two versions of our instrument. In column 3, we use an indicator for whether or not a firm won a close auction in that period, whereas in column 4 we use the share of winnings a firm won in a close auctions. Winning a random contract leads to 1.6 percentage point increase in firm growth, whereas the point estimate in column 4 implies that a 10 percentage point increase in the share of winnings in close auctions increases firm growth by 0.13 percentage points.

In columns 5 and 6, we present the corresponding IV estimates to columns 1 and 2 using the exogenous variation in the share of winnings in close auctions as an instrument (the first-stage regressions are presented in columns 7 and 8). From column 5, the IV estimate on winning a contract is 0.022 compared to 0.010 for the OLS, suggesting that OLS under estimates the effects of winning government contracts. At least two channels could lead

to a downward bias of the OLS coefficients. First, as discussed in Section 3, if government and private contracts serve as substitutes then any decrease in demand from the private sector will also be reflected in the estimates of winning a government contract. Second, if smaller and/or younger firms represent the subpopulation that is most responsive to our instrument (something we will explore later), then this could also be an explanation for why the LATE estimates are larger than the average effects.

Overall the results in Table 6 suggest that winning a government contract leads to an immediate and sizable increase in firm growth. Based on our point estimates, for a firm located at the median of the firm growth distribution, winning a government contract moves the firm to $75^{th}$ percentile of the distribution in that given quarter. Given the size of the contracts, the magnitudes of these effects are not too surprising: the average winnings in a quarter is 11 percent larger than the firm's average wage bill.

For the remainder of the analysis, we will use our indicator for winning a contract as our main independent variable. Besides allowing us to economize on space, we decided to focus on the extensive margin because as we mentioned above only 15 percent of firms win a contract in a given quarter. Having stated this, all of our results hold if we instead base the analysis on our continuous measure.[22]

## 5.2 Heterogeneous Effects

In this section, we explore whether the effects of winning a government contract vary according to characteristics of the firm. We examine three firm attributes that have been emphasized in the literature: the sector of the firm (manufacturing versus retail), the size (small and medium versus large) and the age of the firm (young versus old).

In Table 7, columns 1 and 2 show that the effects of winning a government contract are much more pronounced among retail firms compared to manufacturing firms.[23] The effects on growth for retail firms are almost twice the size of those for manufacturing firms once we account for the fact that retail firms tend to grow more slowly (2.3 percent for retail firms compared to 3.0 for manufacturing firms). One explanation for this differential response has to do with the relative size of the shocks. Although we do not have data on

[22]These results are available upon request.

[23]We identify manufacturing firms based on their Classificação Nacional de Atividades Econômicas (CNAE) code, which is the Brazilian counterpart to the U.S. ISIC codes.

revenue, the total wage bill of manufacturing firms is more than 5 times the wage bill of retail firms, and these firms win similar contract amounts. Thus, the effective size of the demand shock for manufacturing firms is considerably smaller.

In columns 3 and 4 we examine whether winning government contracts has a differential effect based on the initial size of the firm, as measured prior to the start of the online auctions. Based on their initial size, we divide firms into two groups: those below the median and those above median.[24] Among the firms above the median, winning a government contract increases growth in employment by 2.3 percentage points compared to 2.6 percentage points for smaller firms. Although this difference is small, it could still just reflect differences in the age of the firm.

In Figure 5, we examine the extent to which the effects of winning a government contract vary according to the age of the firm. As in Figure 4, we divide firms according to varies age bins (e.g. 0-4,5-9,10-14, etc). For each bin, we estimate the effects of winning a contract on firm growth. In order to isolate the effects by firm age (as opposed to firm size), we also allow the treatment effect to vary by the firm's initial size.[25] In Figure 5, we plot these IV estimates along with their 95 percent point-wise confidence intervals. The effects for younger firms (i.e. firms that are less than 5 years of age) is twice the size of the effects for firms that are between 5 and 15 years of age, and more than 4 times the effects size among firms 25 years and older.

The fact that younger firms respond more to demand shocks, even conditional on their size, is consistent with a nascent but growing literature that emphasizes the importance of demand factors for firm growth. As Fort et al. (2013) and others have documented, young firms grow faster than older firms even conditional on firm size. Since models with only idiosyncratic productivity shocks cannot fully explain firm dynamics over the life cycle, a new class of models have begun to focus on factors such as organizational capital or learning about demand. Our findings are consistent with such theories (e.g. Arkolakis et al. (2014)), where younger firms, by participating in these government auctions, learn about their products' demand, and adjust their production accordingly.

[24] Based on their initial size, the median firm in our sample had 3 employees prior to the start of the auction.

[25] Specifically, for each age bin we re-estimate our main IV specification including an interaction term for winning a contract and the initial size of the firm. The interaction term is not statistically significant in any of the regressions.

## 5.3 Are the effects of government contracts persistent?

Thus far we have documented that firms who win a government contract experience growth during the quarter. If firms hire additional workers to simply fill the contract, then we would not expect this growth to persist beyond the length of the contract.[26] Given the length of our panel data, we can estimate the effects of winning a contract not only for the same quarter, but also for future periods.

In Figure 6 we plot the effects of winning a government contract on growth rates for different periods of time. As an example, for quarter 2 we estimate the effects of winning a contract on growth defined over two periods (i.e. $g_{it} = E_{i,t+1} - E_{i,t-1} / (0.5 \times E_{i,t+1} + 0.5 \times E_{i,t-1})$). As the figure depicts, the effects of winning a contract extend well beyond the average contract length of a year. Even two years after winning the contract, firm growth is almost 4 percentage points higher. In fact, the effects remain positive and statistically significant for at least 9 quarters.

## 5.4 Mechanisms of Persistence

Why does winning a contract lead to such persistent effects? There are two broad explanations. First, winning a government contract could be providing information to the firm about the demand for its products. As firms learn more about their demand over time, they decide to grow. In our setting, firms face uncertainty both in the demand for its products, as well as the marketplace itself. By winning a government contract, firms may start to realize that their products can be sold not only to their own local government, but to governments in neighboring municipalities and states.

Second, winning a government contract may encourage firms to investment more in organizational and human capital. If firms are credit constrained, then winning a government contract could allow firms to further invest in organizational upgrading. For example, firms may want to hire someone devoted entirely to managing the logistics of the online marketplace (i.e. bidding, finalization of the contracts, etc.). If firms reorganize their workforce or investment in more human capital in response to these demand shocks, they are likely to become more competitive and productive over time, which would explain the persistence in growth even after the contracts expire.

[26] The average contract length in these auctions is 12 months.

Unfortunately, we do not have the data to distinguish between these hypotheses. We do however provide evidence that winning a contract, even by a small margin, dramatically affects the way firms behave in the marketplace. Not only are they much more likely to participate (and win) in future auctions, but they also begin to diversify in the types of auctions they participate in, which is consistent with our learning mechanism.

### 5.4.1 Learning in Auctions

Figure 7 displays a series of plots depicting the effects of winning a close auction on a firm's performance and participation in future auctions. The estimation sample is at the auction level and based on auctions in which at least two firms bid within 30 seconds of the end of the auction. The horizontal axis of each plot denotes the difference between the winning bid and second place bid as a share of the second place bid. In the top panel, we plot different outcomes measured over a 30 day window the day after the auction. The figures show that after a firm wins a close auction, they enter more auctions, win more contracts, and win a larger share of the auctions they enter. Interestingly, these differences persist even when we examine these outcomes over a 30-day window, one year after the auction took place (see bottom panel). This pattern of persistence in our auction setting is consistent with the persistent effects that we documented on firm growth.

In Table 8, we present these results in a regression format. For each outcome we present the estimation results for a 30 days window for 30 days, 90 days, and 1 year after the close auction took place. Then, for each period of time and outcome, we show three different specifications that vary the functional form assumptions about the running variable (i.e. the win margin): a third-order polynomial in win margin, a linear spline in win margin, and a cubic spline.

The regression results confirm the patterns seen in the figures. Winning a close auction today implies an increase of approximately 60 percent in the value of contracts that a firm wins over the next 30 days (see Panel A). Even after 1 year, these firms are still winning on average 30 percent more. Three non-mutually exclusive mechanisms can lead to more total contract winnings: winning firms are either participating in more future auctions, or participating in more valuable future auctions, or winning a higher share of the auctions that they participate in. In panels B-D, we see that all three margins are at play. Firms that win a close auction will participate in 40 percent more auctions over the next 3 months

compared to those that barely lose the auction (panel B). Even one year out, close winners are still participating in 20 percent more auctions compared to close losers. Winning firms also win a higher share of future auctions: 90 days after winning a close auction, the winning firm's win rate will be on average 1.5 percentage points higher than the losing firm. This difference is however only 0.7 percentage points, one year after winning the initial auction. Finally, in panel D, we see that 30 days after winning a close auction, the winners win auctions that are 4.6 percent larger than firms that lose. The effects persist 3 months afterwards, but dissipate one year out.

In Table 9, we explore two other participation decisions made by the firm. The first decision is whether a firm decides to participate in an auction that is located outside of its own city. The second decision is whether a firm decides to sell different products to the government. In both cases, we would expect that winning an auction might lead firms to explore access to other types of markets, both in terms of products and location.

In Panel A, we estimate the effects of winning a close auction on the share of auctions a firm participated in that is located outside of its own city. Our estimates suggest that winning a close auction reduces the share of auctions that a firm participate in their own locality by 2.5 percentage points or by 16 percent (calculated with respect to the mean of 0.15). The effects in the short run (columns (1) to (3)) are similar to those one year after the event (columns (7) to (9)). In Panels B, C, and D we show results for diversification of products. We measure diversification in three ways: the number of different product codes, the share of auctions in the top product code of the firm, and the share of auctions in the top 3 product codes. The estimates suggest that winners of close auctions are also more likely to participate in auctions of different products. For instance, in panel B we show that winning a close auction increases the number of product codes that a firm participates in by almost 15 percent. Similar evidence emerges in Panels C and D. In both cases, winning firms are much less likely to participate in these auctions, suggesting that they diversify to other products. Moreover, these diversification effects are present both in the short run, as well as the in long run.

In sum, these results suggest an important reason why firm growth persists over time. Winning a close auction in a given period translates into winning several contracts in the future, as firms not only win more auctions, but also penetrate more markets.

### 5.4.2 Organizational upgrading

Investments in organizational capital can also explain why our effects persist over time. In Figure 5, we documented that the effects of winning a contract on firm growth are larger among younger firms, even conditional of firm size. While this pattern may reflect a learning story, it is also consistent with theories of organizational upgrading. Models with organizational capital accumulation, such as Akcigit et al. (2014), Caliendo and Rossi-Hansberg (2012), and Atkeson and Kehoe (2005), predict that as firms grow, they add more organizational layers, which allows for more knowledge specialization and division of labor.[27] If winning a contract allows younger firms to overcome the fix cost of hiring a professional managers or of decentralizing the decision making within the firm, then we would expect younger firms to respond more to a demand shock than older firms.

To test this mechanism explicitly, one would ideally have data on management practices or the internal organization of the firm. Unfortunately for our sample of firms, such data do not exist. So instead, we use the average education of the work force as a measure of organizational capacity. In Table 10, we present a set of IV regression results, using data at the firm-quarter level. For each regression, the dependent variable is the average years of schooling of the workforce, and as before we include both firm and time intercepts. In column 1, we estimate the model for the entire sample, and in columns 2-6 we estimate the model by firm-age bins to test whether the effects vary by age.

Firms that win a government contract do upgrade the education level of their work force, but the effects are quite small. According to our estimates, winning a government contract leads to 0.025 year increase in the average education of its workers. Given that the education level of workers for an average firm is 10.15 years of schooling, this impact amounts to less than a 0.25 percent increase. There also does not appear to be any systematic relationship between the effects of winning a contract on education by firm age. The effects are slightly more pronounced for firms less than 10 years old, but still small. In the end, while firms may be investing in other forms of organizational capital, we do not find any evidence that winning additional contracts leads to improvements in workforce quality.

[27] These models have received recent empirical support by Kueng et al. (2014).

## 5.5 Robustness to endogenous participation

One potential concern with the results presented above is that the estimation treats the participation decision into the auctions as exogenous. Moreover, one might be concerned that the number of close auctions a firm is involved in is a function of the number of auctions it participated in the past.

In Table 11 we test the robustness of our main results by controlling for the participation of firms in several different ways. First, we control for the number of auctions a firm participates in during the quarter. Second, we control for the ex-ante probability that a firm wins an auction based on the firm's past win rates. Third, we account for the sample selection directly by estimating a selection equation as discussed in Section 3.

In column 1, we present the estimation of Equation 6, which includes a Mills Ratio to corrects for sample selection. As we discussed in Section 3, identification of the Mills Ratio comes from the share of close auctions the firm won in the previous period. The estimates in column 1 suggest that if anything we are under-estimating the effects of winning a government contract on firm growth: Firms that won a government contract grew by 2.6 percent during the quarter.

In column 2, we extend the model estimated in column 1 to flexibly control for the number of auctions the firm participated in during the quarter. By conditioning on the number of auctions a firm participated in, we can account for the fact that firms that participate in more auctions are more likely to win even if winning a close auction is random. As reported in column 2, even after controlling for a $5^{th}$ degree polynomial in the number of auctions, our main point estimate remains virtually unchanged. Of course, the ex-ante probability of winning an auction is not constant across firms, and so even if we are comparing firms who are participating in the same number of auctions, the "effective" number of auctions that they participate in can be quite different. In column 3 we account for this possibility by controlling for a firm's average win rate up until the period. Again, our main estimates remain highly robust. In column 4 we include all three sets of controls (past win rate, number of auctions, Mills Ratio) and again our estimates remain unchanged.

Obviously, the results presented in columns 1-4 condition the sample on participation into an auction. In column 5, we re-estimate our original model using the entire sample (i.e. without the Mills Ratio), but control for the number of auctions a firm participated in

during the quarter and it's average win rate. Perhaps not too surprising given the previous results, the effects are again virtually unchanged. In Panel B, we repeat the exercise for our continuous measure of contract amounts, and our conclusions remain unchanged.

Given that winning a close auction induces participation in future auctions, another way to test for endogenous selection effects is to estimate our main model restricting the sample to just the periods when the firm wins for the first time. This specification check eliminates all future dynamics after a firm wins for the first time. Thus, winning a contract cannot affect future participation by construction. Also note that in this specification we are estimating the employment effects based on variation in the intensive margin, since our sample only comprises of winners. Although we do not report it in the table, we find an IV estimate on the value of contracts a firm won in the quarter of 0.018 (clustered standard error = 0.004), with a sample size of 30,267 observations. The point estimate is larger than those reported in main tables, but the employment growth rate for this sample of firms is also much higher. The magnitude implies that a 10 percent increase in contracts increases employment growth by 4.2 percent, which is actually slightly smaller than the magnitudes of our other point estimates.

## 5.6 Do government purchases create jobs?

Firms that win government contracts grow more both in the short run and in the longer run. This does not imply however, that government contracts are effective at creating jobs. If firms that win contracts poach workers from firms that lose contracts then there would be no employment creation within the local economy. In order to investigate whether formal employment at the local level is created we exploit the fact that our employer-employee data allow us to track workers as they move from one firm to the other, as well as in and out of unemployment or the informal sector.

Specifically, we decompose the growth effects into mutually exclusive categories as follows:

$$g_{i,t} = \frac{E_{i,t} - E_{i,t-1}}{0.5 \times E_{i,t} + 0.5 \times E_{i,t-1}} = \sum_c \frac{E_{i,t,c} - E_{i,t-1,c}}{0.5 \times E_{i,t} + 0.5 \times E_{i,t-1}}$$

where $(E_{i,t,c} - E_{i,t-1,c})/(0.5 \times E_{i,t} + 0.5 \times E_{i,t-1})$ represent category $c^{th}$ contribution to the growth of firm $i$. We start by decomposing firm growth between an increase in hires and a decline in layoffs. We then further decompose the new hires as workers that come from

other firms and workers that come from unemployment or the informal sector.[28] Finally, we decompose the new hired workers who do not come from other (formal) firms into four categories: workers who were out of the (formal) labor market for one, two, three or more than three quarters.

In Table 12, we present the results from re-estimating our main IV specification using as a dependent variable the growth in employment associated with each category. In column 1 we replicate our main result for the effect of winning government contracts. In columns 2 and 3 we decompose the growth effect between layoffs and new hires. The results are quite striking. While firms that won a contract layoff slightly more people (a mean effect of 6.3 percent), the increase in new hires is large enough to produce all of the observed firm growth. We further decompose the growth in employment in two parts: new workers that come from other firms and workers that come from unemployment/informality/out of the labor force. As we see in columns 4 and 5, the increase in hires from unemployment/informality accounts for (0.0252/0.0272 =) 93 percent of the effect of winning a government contract on firm growth. We then categorize the new hires from unemployment/informality according to the number of quarters that they have been outside of the formal labor market in columns 6-9. The contribution of workers who were out of the formal labor market for 4 quarters or more is by far the biggest. That category alone accounts for (0.0158/0.0223 =) 70 percent of the estimated growth effect.

In sum, all of the growth effects we estimate come from firms who, by winning a government contract, hire more workers, relative to those who did not. Ninety-three percent of the growth in new hires comes from hiring workers who are not formally employed, and in fact 58 percent of the growth in new hires comes from hiring workers who are out of the formal labor market for 4 or more quarters, or who had never had a formal job before. Hence, government contracts can have real employment effects by creating new jobs in the formal economy.

# 6 Conclusions

We employ a novel empirical strategy to test whether an exogenous change in the demand for a firm's products affects its growth. We find that firms that win more govern-

[28] We only observe whether a worker does not appear in our data in previous periods, so we do not know whether the worker was unemployed, employed in the informal sector, or out of the labor force.

ment contracts through procurement auctions experience significant increases in growth that persist well beyond the length of the contract. We interpret these persistent effects as the result of firms learning about the demand for their products. Consistent with this interpretation, we find that firms who win a close auction are much more likely to participate more in future auctions, participate in auctions of higher values, and sell a broader set of goods in different markets. Younger firms (even conditional on initial size) also grow relatively more after getting a government contract, which is again consistent with a learning-based story.

While we provide evidence consistent with firms learning about their demand, there are alternative explanations for our findings. One potential explanation is that winning government contracts act as a liquidity shock to the firm. If firms, and particularly younger firms, face a fixed cost in adopting newer technologies and managerial capacities, then a demand shock may allow firms to grow. This would explain the persistent effects of the contracts, as well as the differential effects by age since younger firms tend to be, on average, more credit constrained. Also, although we emphasized a learning story about product demand, firms and customers may also be learning about the firm's product quality. While we cannot reject the liquidity mechanism, we do believe that this second channel is less likely, given that our procurement contracts are strictly based on price bids.

Our results are in line with a growing set of papers that suggest an important role for demand factors in explaining why some firms grow more than others during their life-cycle. Furthermore, our findings shed light on the restrictions faced by firms in developing countries. Lack of access to markets (because of distance or lack of knowledge) seems to play an important role in constraining firm growth. Thus, government policies that could alleviate this constraint either by informing firms of potential markets or reducing barriers to sell in larger markets could enable firms to growth. Such policies may also be particularly relevant for younger firms, which often lack the networks and knowledge to sell in larger markets.

Our results do not necessarily imply that government purchases are an effective way to foster growth and employment. To address this question, we would need to understand what happens to other firms located in the same city as winning firms and whether the effects spill over to downstream suppliers. Also, government purchases might just be substituting for private purchases. If the government acts as a monopolist, this might induce lower competition and might affect product quality in the long-run. Differentiating

among some of these mechanisms should be the focus of future research.

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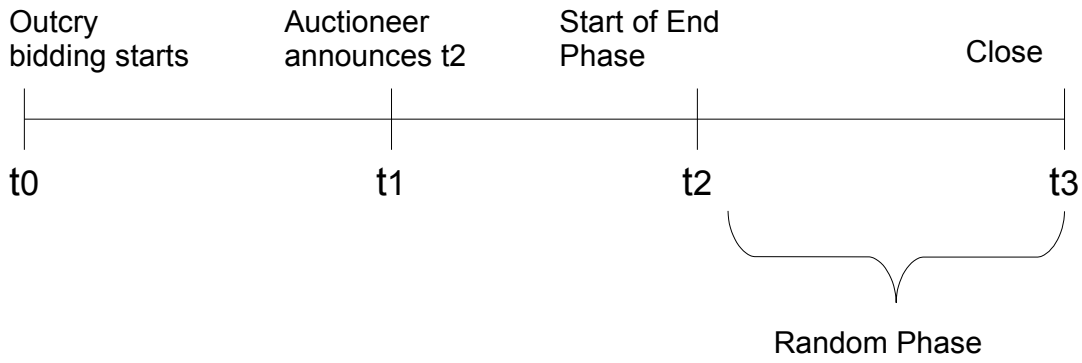



Figure 1: Bidding Timeline

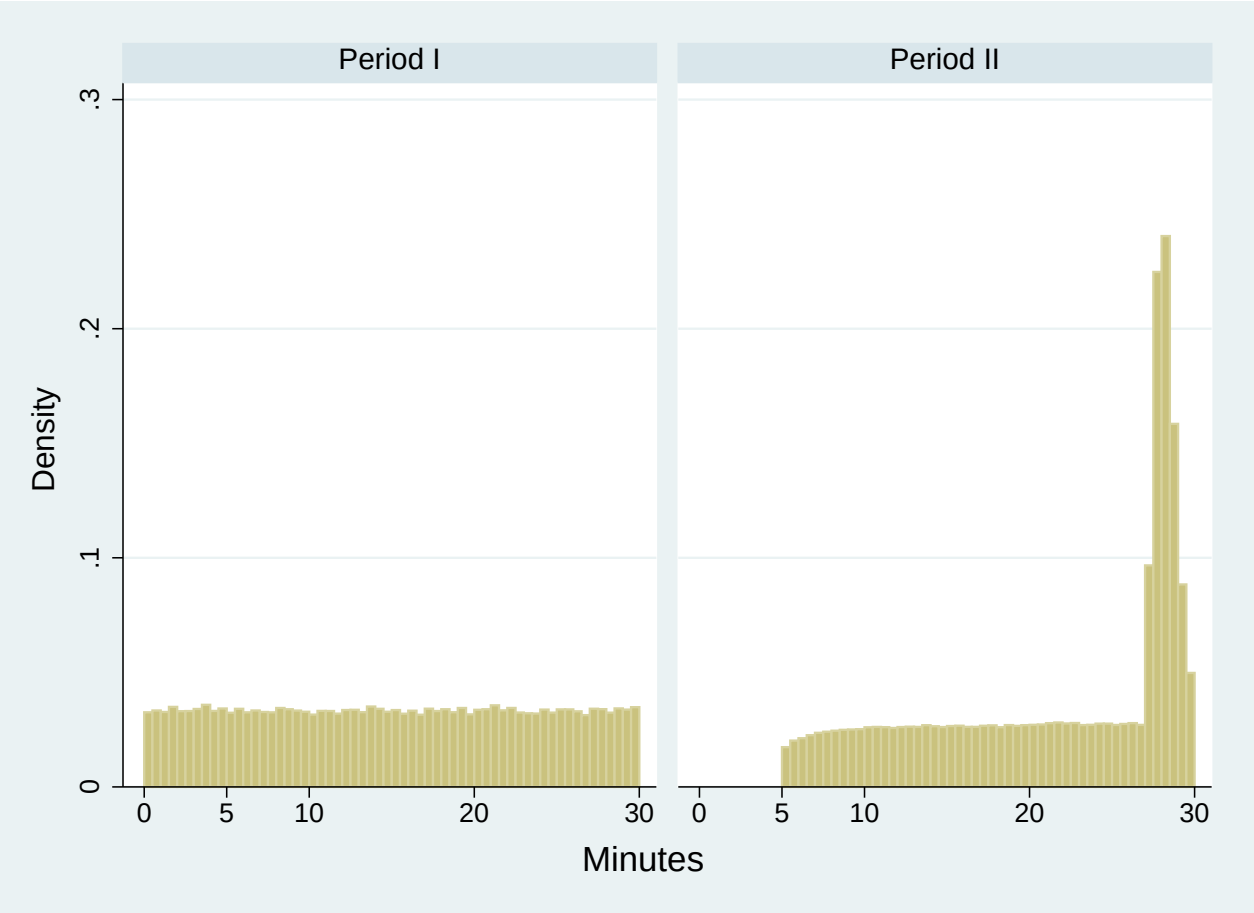



Figure 2: Distribution of Random Duration

Notes: Panel A depicts the distribution of random phases from 2004 to April 2006. In this period, the end phase duration followed a uniform distribution on the $[0, 30]$ minutes interval. Panel B depicts the distribution of random phases after April 2006. This distribution results from the sum of a uniform [5,30] plus one random draw from a uniform [0,2] for each bid placed in the auction, as long as the total time does not exceed 30 minutes.

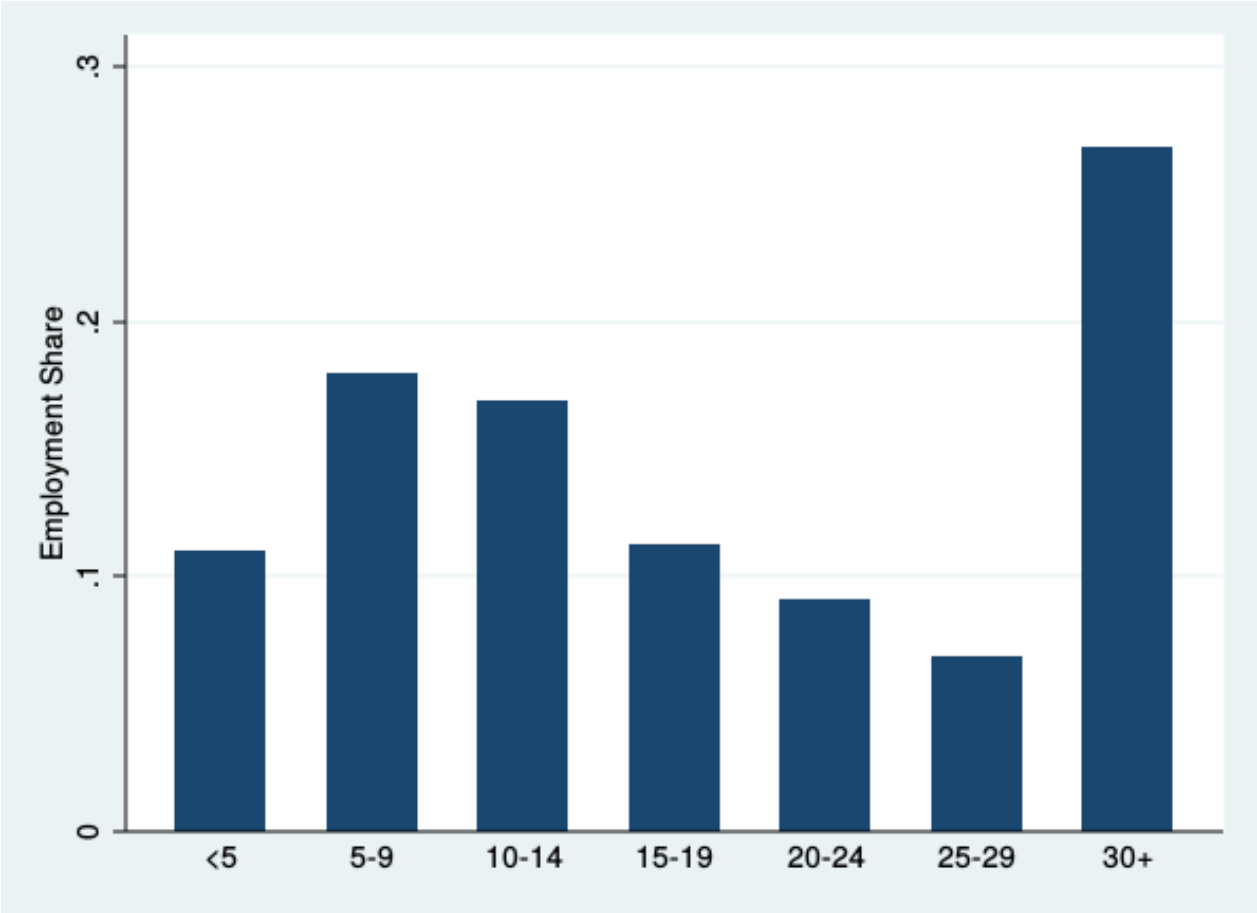



Figure 3: Formal employment by Firm Age

Notes: This figure plot the share of employment by the age of the firm for our sample of firms. The sample size is 42,398 firms.

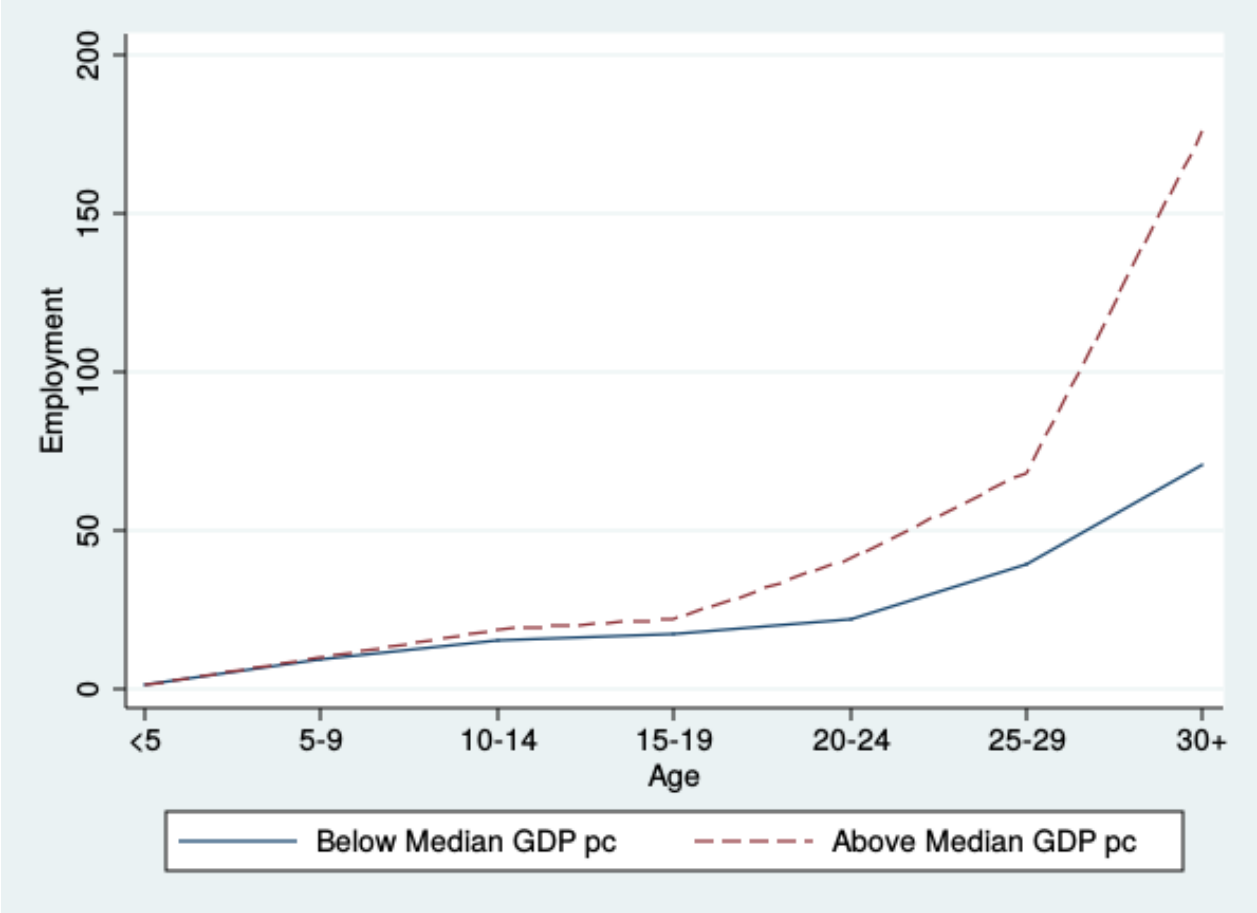



Figure 4: Firm Size by Age

Notes: This figure plots the relationship between firm size and age of the firm, distinguishing between firms that are located in municipalities below the median in per capita GDP and those located above the median. The sample size is 42,398 firms.

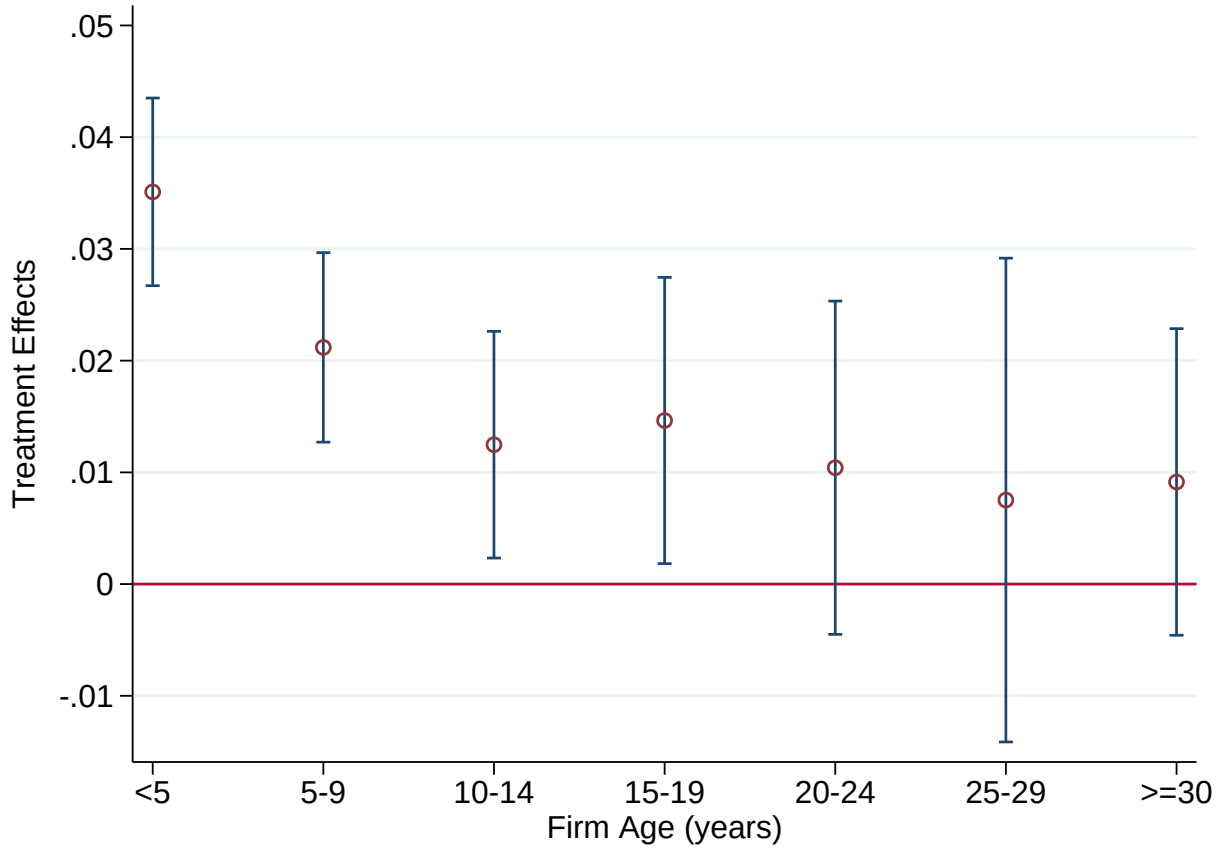



Figure 5: Treatment Effects by Firm Age

Notes: This figure depicts the effects of winning a government contract by age of the firm. For each age bin, we plot the IV estimate along with 95 percent point-wise confidence interval.

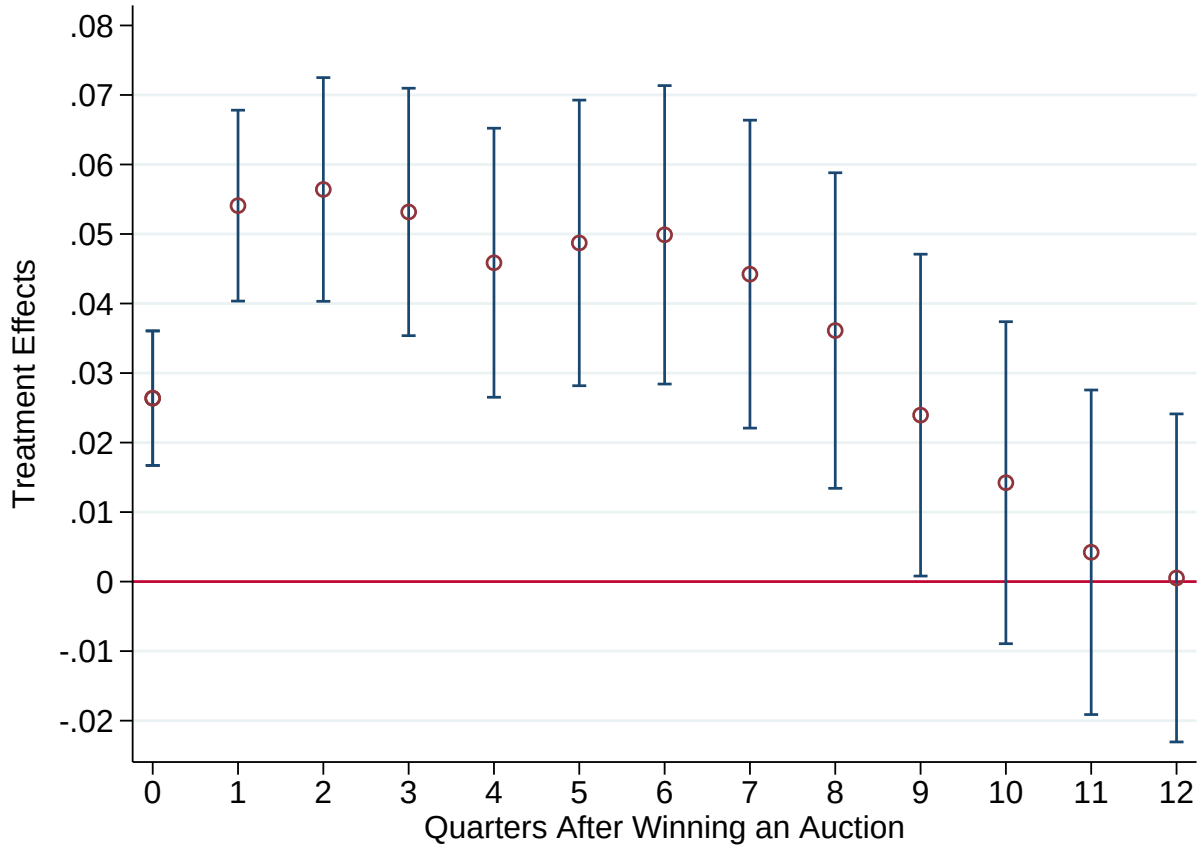
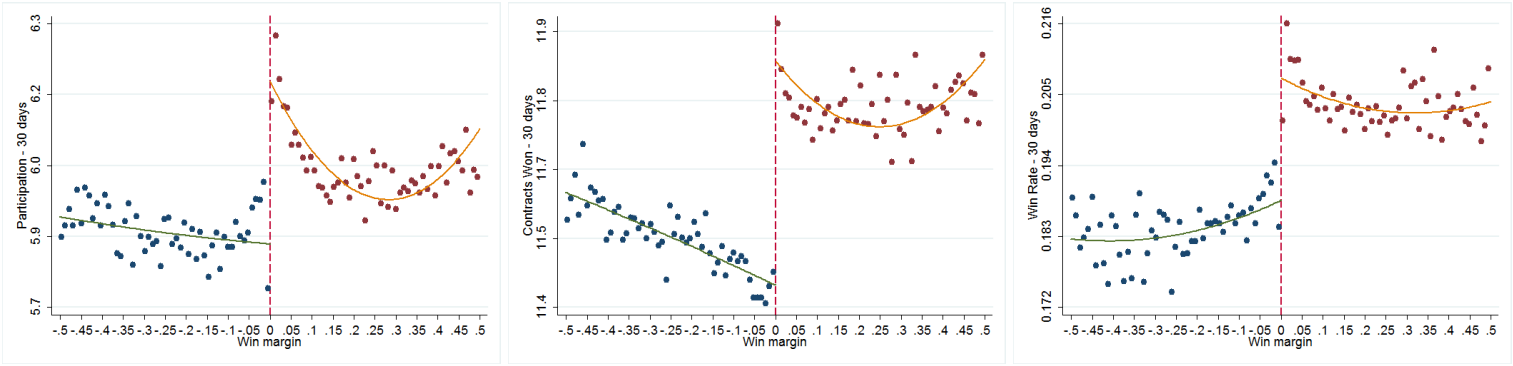



Figure 6: Long Run Effects of Winning an Auction

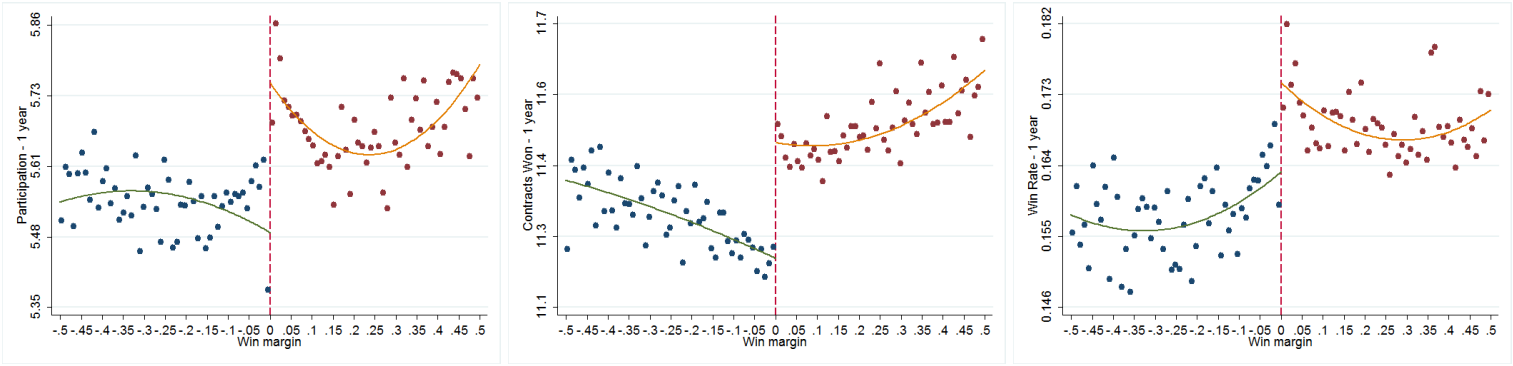
Notes: The figure plots IV estimates for the effects of winning a government contract on growth rates for different periods of time. Firm growth k periods after winning a contract is defined as $g_{it} = E_{i,t+k} - E_{i,t-1}/(0.5 \times E_{i,t+k} + 0.5 \times E_{i,t-1})$. The vertical lines denote the 95 percent point-wise confidence intervals.

Panel A: 30-day window starting at auction day




Participation (log) Value of Winnings (log) Win Rate

Panel B: 30-day window starting 350 days after auction day




Participation (log) Value of Winnings (log) Win Rate

Figure 7: The Effect of Winning a Government Contract on Future Auction outcomes: RD Graphs

Notes: This figure displays a series of plots depicting the effects of winning a close auction on a firm's performance and participation in future auctions. The estimation sample is at the auction level and based on auctions in which at least two firms bid within 30 seconds of the end of the auction. The horizontal axis of each plot denotes the difference between the winning bid and second place bid as a share of the second place bid.

Table 1: 20 Most Frequent Product Categories in ComprasNet: 2004-2010

| | (1) # of Lots | (2) % of Total | (3) Median Lot Estimate | (4) % of Total Value Purchased | (5) # of 4-digit | (6) # of 6-digit |
|---|---|---|---|---|---|---|
| Books, Maps, Other Publications | 502,253 | 12 | 149 | .71 | 7 | 134 |
| Medical & Veterinary Equip | 446,508 | 11 | 780 | 12 | 12 | 31,149 |
| Laboratory Equipment | 398,921 | 9.6 | 500 | 4.7 | 19 | 5,009 |
| Office Supplies and Devices | 312,593 | 7.5 | 323 | 1.6 | 4 | 9,754 |
| Subsistence (Food) | 247,975 | 6 | 2,250 | 5 | 14 | 3,383 |
| IT E&S | 238,268 | 5.7 | 1,892 | 9.1 | 11 | 8,010 |
| Vehicular Equipment Components | 234,852 | 5.6 | 400 | 2.3 | 5 | 976 |
| Electrical/Electronic Equip Com | 151,060 | 3.6 | 310 | .75 | 26 | 6,751 |
| Construction & Building Materia | 121,983 | 2.9 | 1,113 | 3.5 | 8 | 1,283 |
| Chemicals and Chemical Products | 91,431 | 2.2 | 339 | 1.3 | 5 | 4,248 |
| Hardware and Abrasives | 85,683 | 2.1 | 240 | .44 | 16 | 3,181 |
| Pipe, Tubing, Hose, Fittings | 85,338 | 2 | 215 | .34 | 3 | 2,830 |
| Hand Tools | 84,036 | 2 | 149 | .16 | 7 | 2,159 |
| Brushes, Paints & Sealers | 80,374 | 1.9 | 560 | .92 | 4 | 1,673 |
| Furniture | 68,960 | 1.7 | 2,925 | 2.1 | 4 | 2,999 |
| Cleaning E&S | 64,253 | 1.5 | 706 | .42 | 3 | 810 |
| Electric Wire & Power Equipment | 60,760 | 1.5 | 900 | .95 | 13 | 3,013 |
| Food Preparation E&S | 55,806 | 1.3 | 872 | .67 | 6 | 2,098 |
| Maintenance & Installation Serv | 53,768 | 1.3 | 3,200 | 6.1 | 16 | 260 |
| Nonmetallic Fabricated Materials | 46,867 | 1.1 | 564 | .58 | 6 | 2,428 |
| Total | 4,163,599 | $1.0e+02$ | 560 | $1.0e+02$ | 704 | 118,819 |

Notes: Table reports statistics for the 20 most frequent categories in ComprasNet between June 2004 and December 2010. There are 106 categories, as defined by the U.S. Federal Supply Classification for goods and the U.N. Central Product Classification for services. The last row shows total for all categories, not only the ones showed in the table. Column (1) shows the number of lots that attracted at least 2 bidders, in each category. Column (2) shows the percentage each category represents. Column (3) shows the median reservation price of lots within each category. Column (4) shows the share of each category in total value purchased. Column (5) shows the number of subcategories in each category. Subcategories are defined by 4-digit codes of the aforementioned classification schemes. Column (6) shows the number of 6-digit codes in each category. 6-digit codes are created by procurement officers in ComprasNet.

Table 2: Sample Descriptive Statistics: Auctions

| | All auctions | | Close auctions | |
|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. |
| Reserve price | 18155.3 | 620599.2 | 29780.4 | 916777.9 |
| Winning bid | 10314.2 | 340152.8 | 16828.9 | 492363.7 |
| $100x\frac{Ranked2-Ranked1}{Ranked2}$ | 10.0 | 17.9 | 0.13 | 0.14 |
| Winning bid/Reserve | 0.69 | 0.31 | 0.71 | 0.28 |
| Number of Bidders | 7.00 | 4.97 | 8.44 | 5.81 |
| *Auction duration* | | | | |
| Total (minutes) | 66.3 | 55.2 | 70.0 | 53.7 |
| Random phase (minutes) | 21.2 | 8.16 | 26.2 | 5.90 |
| *Number of bids* | | | | |
| Total | 22.7 | 37.4 | 81.4 | 62.5 |
| In random phase | 19.0 | 34.6 | 75.3 | 58.9 |
| In random phase, placed by winner | 6.75 | 12.8 | 27.0 | 22.4 |
| In random phase, placed by runner-up | 5.60 | 11.3 | 24.8 | 21.1 |
| *Response Time to rivals' bids in random phase (seconds)* | | | | |
| Winner's response | 30.2 | 20.7 | 18.1 | 11.1 |
| Runner-up's response | 36.7 | 25.2 | 21.6 | 13.0 |
| *Rank of first bid placed* | | | | |
| Winner | 2.81 | 2.79 | 3.85 | 3.55 |
| Runner-up | 2.95 | 2.77 | 3.62 | 3.46 |
| Number of outbids in random phase | 13.2 | 22.3 | 51.0 | 34.0 |
| *Geographic region of public body* | | | | |
| North | 0.12 | 0.33 | 0.10 | 0.30 |
| Northeast | 0.21 | 0.41 | 0.21 | 0.41 |
| Southeast | 0.33 | 0.47 | 0.32 | 0.47 |
| South | 0.18 | 0.38 | 0.20 | 0.40 |
| Center-West | 0.16 | 0.37 | 0.17 | 0.38 |
| Number of auctions | 4,291,040 | | 265,642 | |

Notes: Table shows summary statistics for auctions held by federal purchasing units between June 2004 and December 2010 in which at least two firms participate. See data appendix for a detailed description of filters used. We define close auctions as those auctions where (i) both the winner and runnerup placed bids in the last 30 seconds of the auction, and (ii) the runnerup bid does not exceed the winning bid by more than 0.5%. Monetary values are measured in 2010 R$.

Table 3: Sample Descriptive Statistics: Firms

| | Firms Participating in Auctions | | All Firms | |
|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. |
| *Number of employees* | | | | |
| Total | 28.2 | 194.1 | 11.5 | 78.5 |
| Temporary | 0.43 | 14.7 | 0.20 | 10.5 |
| Growth | 0.021 | 0.24 | 0.015 | 0.31 |
| *Number of new hires* | | | | |
| Total | 3.64 | 34.7 | 1.62 | 18.0 |
| From other firms | 0.77 | 11.3 | 0.25 | 3.91 |
| Not from other firms | 2.88 | 28.8 | 1.37 | 15.3 |
| From same municipality | 1.38 | 9.50 | 0.59 | 5.32 |
| Layoffs | 3.11 | 36.6 | 1.49 | 20.0 |
| *Employees' Characteristics* | | | | |
| Average monthly wages | 880.5 | 1276.9 | 746.7 | 837.4 |
| Average hourly wages | 20.7 | 31.3 | 18.0 | 23.9 |
| Average years of schooling | 7.93 | 4.50 | 8.09 | 3.95 |
| Wage bill (R$1,000) | 164.1 | 1811.6 | 43.4 | 668.2 |
| *All auctions...* | | | | |
| Participated | 31.5 | 268.5 | | |
| Won | 4.80 | 58.3 | | |
| Winnings (R$1,000) | 183.2 | 130350.9 | | |
| *Close auctions...* | | | | |
| Participated | 0.55 | 7.74 | | |
| Won | 0.28 | 4.63 | | |
| Winnings (R$1,000) | 4.14 | 227.4 | | |
| Number of firms | 42,398 | | 3,979,261 | |
| Observations | 962,562 | | 62,277,196 | |

Notes: Table shows summary statistics for a quarterly unbalanced panel of firms from 2004Q3 to 2010Q4. Growth in quarter $t$ is defined as the difference between the number of employees at the end of quarters $t$ and $t-1$, divided by the average number of employees in the end of the two quarters.

Table 4: Winners vs Runnerups: Sample Balance

| | Runnerups | | Winners | | |
|---|---|---|---|---|---|
| | Mean | Std. Dev | Mean | Std. Dev | p-value |
| Sample: 265,749 auctions with 2 active bidders in last 30 seconds; bid difference <0.005 | | | | | |
| Number of Employees in previous quarter | 12.96 | 111.2 | 10.43 | 94.7 | 0.13 |
| Growth rate in previous quarter | 0.05 | 0.3 | 0.06 | 0.3 | 0.88 |
| Growth rate in previous 12 months | 0.18 | 0.5 | 0.20 | 0.5 | 0.63 |
| Average real wages in previous quarter | 634.58 | 622.5 | 612.66 | 615.5 | 0.09 |
| Employees' Schooling in previous quarter | 7.30 | 4.9 | 7.19 | 4.9 | 0.23 |
| Accumulated win rate | 0.19 | 0.1 | 0.20 | 0.1 | 0.36 |
| Bidder in same city as Auction | 0.22 | 0.4 | 0.19 | 0.4 | 0.81 |
| Bidder registred as SME | 0.90 | 0.3 | 0.94 | 0.2 | 0.11 |
| Sample: 108,604 auctions with 2 active bidders in last 12 seconds; bid difference <0.005 | | | | | |
| Number of Employees in previous quarter | 11.21 | 107.4 | 9.25 | 90.1 | 0.06 |
| Growth rate in previous quarter | 0.06 | 0.3 | 0.06 | 0.3 | 0.43 |
| Growth rate in previous 12 months | 0.20 | 0.5 | 0.21 | 0.5 | 0.38 |
| Average real wages in previous quarter | 620.22 | 595.4 | 598.53 | 584.5 | 0.21 |
| Employees' Schooling in previous quarter | 7.23 | 4.9 | 7.07 | 5.0 | 0.27 |
| Accumulated win rate | 0.18 | 0.1 | 0.19 | 0.1 | 0.23 |
| Bidder in same city as Auction | 0.19 | 0.4 | 0.16 | 0.4 | 0.93 |
| Bidder registred as SME | 0.93 | 0.3 | 0.96 | 0.2 | 0.07 |
| Sample: 143,500 auctions with 2 active bidders in last 30 seconds; bid difference <0.001 | | | | | |
| Number of Employees in previous quarter | 13.86 | 125.6 | 10.40 | 103.0 | 0.10 |
| Growth rate in previous quarter | 0.06 | 0.3 | 0.06 | 0.3 | 0.41 |
| Growth rate in previous 12 months | 0.18 | 0.5 | 0.20 | 0.5 | 0.30 |
| Average real wages in previous quarter | 645.34 | 631.3 | 601.70 | 622.0 | 0.04 |
| Employees' Schooling in previous quarter | 7.32 | 4.9 | 7.03 | 5.0 | 0.09 |
| Accumulated win rate | 0.19 | 0.1 | 0.20 | 0.1 | 0.20 |
| Bidder in same city as Auction | 0.21 | 0.4 | 0.18 | 0.4 | 0.74 |
| Bidder registred as SME | 0.89 | 0.3 | 0.93 | 0.2 | 0.05 |

Notes: Table shows means and standard deviations of selected variables for winners and runnerups of close auctions, for different deffinitions of closeness. p-value test for the null that the means are the same, and are obtained from a regression with auction-fixed effects and standard-errors clustered at the firm level.

Table 5: Placebo test: Who would win a close auction had it ended seconds before?

| | winner | runner-up |
|---|---|---|
| 2 seconds | 0.672 | 0.267 |
| 6 seconds | 0.498 | 0.429 |
| 8 seconds | 0.457 | 0.465 |
| 12 seconds | 0.423 | 0.484 |
| 18 seconds | 0.445 | 0.441 |
| 24 seconds | 0.500 | 0.371 |
| Number of Auctions | 265,714 | |

Notes: To compute the figures shown in this table, we artifically end auctions early and see which firm would win it under the new duration. Column (1) shows the fraction of auction where the winner's identity would not change. Column (2) shows the fraction of auction in which the runner up would be the new winner under the new duration. Note that it is possible that a third firm would win the auction, so the two columns do not add to one. The first row cuts actuall auction durations by 5 seconds. The other rows are analogous.

Table 6: The Effects of Winning a Contract on Firm Growth

| Dependent variable | Firm Growth | | | | | | Won | Amount Won |
|---|---|---|---|---|---|---|---|---|
| | (1) OLS | (2) OLS | (3) Reduced-form | (4) Reduced-form | (5) IV | (6) IV | (7) First-stage | (8) First-stage |
| Won | 0.010 | | | | 0.022 | | | |
| | [0.001] | | | | [0.002] | | | |
| Amount Won (logs) | | 0.001 | | | | 0.002 | | |
| | | [0.000] | | | | [0.000] | | |
| Won a close auction | | | 0.016 | | | | 0.697 | |
| | | | [0.001] | | | | [0.002] | |
| Share of close auctions won | | | | 0.013 | | | | 7.686 |
| | | | | [0.002] | | | | [0.022] |
| $R^2$ | 0.052 | 0.052 | 0.052 | 0.052 | -0.000 | 0.000 | 0.456 | 0.468 |
| Observations | 962,562 | 962,562 | 962,562 | 962,562 | 962,531 | 962,531 | 962,562 | 962,562 |
| Mean dep. var. | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 | 0.145 | 1.505 |

Notes: All specifications include firm fixed effects and quarter dummies. Standard errors clustered by firm in brackets. Firm growth is defined as the change in the firm's number of employees between the end of the previous and current quarters divided by the average number of employees between the two quarters.

Table 7: The Effects of Winning a Contract on Firm Growth: Heterogeneous Effects by Firms' Characteristics

| | Sector | | Firm Size | |
|---|---|---|---|---|
| | (1) Manufacturing | (2) Non-Manufacturing | (3) Below Median | (4) Above Median |
| Won a contract | 0.018 | 0.023 | 0.026 | 0.023 |
| | [0.006] | [0.002] | [0.003] | [0.003] |
| Observations | 176,982 | 785,549 | 403,739 | 545,329 |
| Mean dep. var. | 0.030 | 0.023 | 0.041 | 0.008 |

Notes: Table shows IV estimates for the effect of winning a government contract on firm growth. All specifications include firm fixed effects and quarter dummies. Standard errors clustered by firm in brackets.

Table 8: The Effects of winning a Contract on Future Auction Outcomes

| | 30 days | | | 90 days | | | 1 year | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| *Panel A: Winnings in particpated auction (log)* | | | | | | | | | |
| Winner | 0.579 | 0.593 | 0.643 | 0.530 | 0.544 | 0.588 | 0.337 | 0.341 | 0.342 |
| | [0.045] | [0.048] | [0.059] | [0.041] | [0.043] | [0.053] | [0.084] | [0.090] | [0.116] |
| Observations | 453,668 | 453,668 | 453,668 | 479,962 | 479,962 | 479,962 | 513,716 | 513,716 | 513,716 |
| Mean of Dep. Var. | 11.29 | 11.29 | 11.29 | 12.32 | 12.32 | 12.32 | 5.51 | 5.51 | 5.51 |
| *Panel B: Number of auctions participated (log)* | | | | | | | | | |
| Winner | 0.393 | 0.411 | 0.468 | 0.397 | 0.414 | 0.466 | 0.194 | 0.200 | 0.212 |
| | [0.031] | [0.033] | [0.041] | [0.032] | [0.034] | [0.042] | [0.052] | [0.056] | [0.073] |
| Observations | 513,716 | 513,716 | 513,716 | 513,716 | 513,716 | 513,716 | 513,716 | 513,716 | 513,716 |
| Mean of Dep. Var. | 5.71 | 5.71 | 5.71 | 6.59 | 6.59 | 6.59 | 3.10 | 3.10 | 3.10 |
| *Panel C: Win rate* | | | | | | | | | |
| Winner | 0.017 | 0.017 | 0.016 | 0.015 | 0.015 | 0.014 | 0.008 | 0.008 | 0.007 |
| | [0.004] | [0.005] | [0.006] | [0.004] | [0.005] | [0.006] | [0.003] | [0.003] | [0.004] |
| Observations | 479,146 | 479,146 | 479,146 | 495,638 | 495,638 | 495,638 | 214,248 | 214,248 | 214,248 |
| Mean of Dep. Var. | 0.195 | 0.195 | 0.195 | 0.191 | 0.191 | 0.191 | 0.170 | 0.170 | 0.170 |
| *Panel D: Winnings/Number Won* | | | | | | | | | |
| Winner | 0.046 | 0.045 | 0.042 | 0.032 | 0.030 | 0.028 | -0.011 | -0.012 | -0.016 |
| | [0.014] | [0.015] | [0.018] | [0.018] | [0.019] | [0.023] | [0.020] | [0.021] | [0.024] |
| Observations | 435,612 | 435,612 | 435,612 | 469,660 | 469,660 | 469,660 | 167,296 | 167,296 | 167,296 |
| Mean of Dep. Var. | 7.35 | 7.35 | 7.35 | 7.54 | 7.54 | 7.54 | 7.31 | 7.31 | 7.31 |
| Controls | Cubic polyno-mial | Linear Spline | Cubic spline | Cubic polyno-mial | Linear Spline | Cubic spline | Cubic polyno-mial | Linear Spline | Cubic spline |

Notes: Sample is winners and runner-ups in close auctions. Each coefficient is the effect of being the winner in a close auction, controling for auction fixed-effects and flexible controls on the winning margin, as described in the last row. Standard errors clustered by firm in brackets. In columns (1)-(3), outcomes are measure in a 30-day window starting the day after the auction. In columns (4)-(6), outcomes are measured in a 90-day window starting the day after the auction. In columns (7)-(9), outcomes are measured in a 30-day window centered around 365 days after the auction.

Table 9: The Effects of winning a Contract on Future Auction Outcomes

| | 30 days | | | 90 days | | | 1 year | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| *Panel A: Share of participated auctions in the same city* | | | | | | | | | |
| Winner | -0.025 | -0.025 | -0.026 | -0.024 | -0.025 | -0.027 | -0.019 | -0.019 | -0.018 |
| | [0.002] | [0.003] | [0.003] | [0.002] | [0.002] | [0.003] | [0.003] | [0.003] | [0.004] |
| Observations | 477,926 | 477,926 | 477,926 | 494,406 | 494,406 | 494,406 | 213,814 | 213,814 | 213,814 |
| Mean of Dep. Var. | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 |
| *Panel B: Number of different product codes* | | | | | | | | | |
| Winner | 5.8 | 6.0 | 7.1 | 7.7 | 8.0 | 9.4 | 1.9 | 1.9 | 2.1 |
| | [0.9] | [1.0] | [1.1] | [1.2] | [1.2] | [1.4] | [0.4] | [0.4] | [0.5] |
| Observations | 510,946 | 510,946 | 510,946 | 510,946 | 510,946 | 510,946 | 510,946 | 510,946 | 510,946 |
| Mean of Dep. Var. | 30.8 | 30.8 | 30.8 | 45.1 | 45.1 | 45.1 | 15.3 | 15.3 | 15.3 |
| *Panel C: Share of auctions in the top product code* | | | | | | | | | |
| Winner | -1.8917 | -1.9890 | -2.3142 | -1.5990 | -1.6926 | -2.0302 | -0.8402 | -0.8735 | -0.9009 |
| | [0.2679] | [0.2810] | [0.3333] | [0.2622] | [0.2738] | [0.3205] | [0.2411] | [0.2557] | [0.3196] |
| Observations | 472,536 | 472,536 | 472,536 | 490,922 | 490,922 | 490,922 | 206,904 | 206,904 | 206,904 |
| Mean of Dep. Var. | 53.46 | 53.46 | 53.46 | 51.23 | 51.23 | 51.23 | 55.85 | 55.85 | 55.85 |
| *Panel D: Share of auctions in the top 3 product codes* | | | | | | | | | |
| Winner | -2.0410 | -2.1623 | -2.6537 | -1.9097 | -2.0215 | -2.4660 | -1.0062 | -1.0664 | -1.2840 |
| | [0.3035] | [0.3178] | [0.3786] | [0.3005] | [0.3134] | [0.3692] | [0.2606] | [0.2778] | [0.3474] |
| Observations | 472,536 | 472,536 | 472,536 | 490,922 | 490,922 | 490,922 | 206,904 | 206,904 | 206,904 |
| Mean of Dep. Var. | 72.47 | 72.47 | 72.47 | 69.84 | 69.84 | 69.84 | 75.51 | 75.51 | 75.51 |
| Controls | Cubic polyno-mial | Linear Spline | Cubic spline | Cubic polyno-mial | Linear Spline | Cubic spline | Cubic polyno-mial | Linear Spline | Cubic spline |

Notes: Sample is winners and runner-ups in close auctions. Each coefficient is the effect of being the winner in a close auction, controling for auction fixed-effects and flexible controls on the winning margin, as described in the last row. Standard errors clustered by firm in brackets. In columns (1)-(3), outcomes are measure in a 30-day window starting the day after the auction. In columns (4)-(6), outcomes are measured in a 90-day window starting the day after the auction. In columns (7)-(9), outcomes are measured in a 30-day window centered around 365 days after the auction.

Table 10: The Effects of Winning a Government Contract on Employee's years of schooling

| | | Firm Age (years) | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) <5 | (3) 5-9 | (4) 10-14 | (5) 15-19 | (6) 20+ |
| Won | 0.025 | 0.042 | 0.058 | -0.016 | -0.007 | 0.043 |
| | [0.014] | [0.025] | [0.023] | [0.028] | [0.034] | [0.032] |
| Observations | 702,055 | 154,744 | 189,694 | 138,131 | 88,760 | 130,208 |
| Mean dep. var. | 10.1497 | 10.3518 | 10.2092 | 10.1276 | 10.0468 | 9.9153 |

Notes: All specifications include firm fixed effects and quarter dummies. Standard errors clustered by firm in brackets.

Table 11: The Effects of Winning a Government Contract on Firm Growth: Controlling for Selection

| | Dependent Variable: Employment Growth | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A* | | | | | |
| Won | 0.026 | 0.024 | 0.029 | 0.026 | 0.029 |
| | [0.005] | [0.006] | [0.005] | [0.007] | [0.004] |
| Inverse Mill's ratio | -0.001 | -0.001 | -0.002 | -0.002 | |
| | [0.003] | [0.003] | [0.003] | [0.003] | |
| *Panel B* | | | | | |
| Amount Won (logs) | 0.002 | 0.001 | 0.002 | 0.002 | 0.002 |
| | [0.000] | [0.001] | [0.000] | [0.001] | [0.000] |
| Inverse Mill's ratio | -0.001 | -0.001 | -0.002 | -0.001 | |
| | [0.002] | [0.002] | [0.002] | [0.002] | |
| Number of Auctions Participated | No | Yes | No | Yes | Yes |
| Cummulative Win Rate (t-1) | No | No | Yes | Yes | Yes |
| Observations | 209,625 | 209,625 | 209,625 | 209,625 | 962,531 |
| Mean dep. var. | 0.0262 | 0.0262 | 0.0262 | 0.0262 | 0.0240 |

Notes: All specifications include firm fixed effects and quarter dummies. Standard errors clustered by firm in brackets. Columns (1) shows IV estimates from the same specification used in Table 6 restricting the sample to firms-quarters with positive participation in auctions. Column (2) adds controls. Columns (3)-(6) shows IV estimates controlling for the inverse Mill's ratio obtained in a probit regression for the probability of participation, as described in Equation 6.

Table 12: Decomposing the Effects on Firm Growth: Hires and Layoffs

| | (1) Growth | (2) Layoffs | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | | | New Hires | | | | | | |
| | | | Total | From Other Firms? | | | | | |
| | | | | Yes | No | | | | |
| | | | | | Total | How many quarters out of the Labor Market? | | | |
| | | | | | | 1 | 2 | 3 | 4+ |
| Won a contract | 0.0223 | 0.0047 | 0.0272 | 0.0020 | 0.0252 | 0.0022 | 0.0039 | 0.0033 | 0.0158 |
| | [0.0020] | [0.0012] | [0.0017] | [0.0006] | [0.0015] | [0.0004] | [0.0005] | [0.0004] | [0.0012] |
| Observaions | 962,531 | 962,531 | 962,531 | 962,531 | 962,531 | 962,531 | 962,531 | 962,531 | 962,531 |
| Mean of Dep. Variable | 0.024 | 0.074 | 0.099 | 0.017 | 0.082 | 0.009 | 0.010 | 0.007 | 0.056 |

Notes: This table decomposes firms' growth into hires minus layoffs, appropriately divided by the average number of employees between quarters. In column 1, the dependnt variable is firm's growth. In column 2 the dependent variable is the number of layoffs in quarter $t$. In column 3 the dependent variable is the number of new hires between quarters $t$ and $t-1$. Columns 4 and 5 further decompose new hires. The dependent variable in column 4 is the number of new hires who were employed by another firm in the previous quarter. The dependent variable in column 5 in the number of new hires who were not employed by another firm in the previous quarter. Column 6-9 decompose the dependent variable of column 5 intro the number of new hires who were last employed by another firm 2, 3, 4 or more than 4 quarter ago, respectively. The last category also includes hires who had never been formally employed. All regressions include firm-fixed effects and quarter dummies. Standard errors clustered by firm in brackets.

# A Appendix: Equilibrium Bidding Behavior

Consider an environment, where there is a single seller auctioning a single indivisible object. Suppose there are $n \geq 2$ bidders denoted by $N = \{1, 2, \dots, n\}$. Each bidder has a private valuation $v_i \in [0, \bar{v}]$ that is drawn identically and independently according to some distribution $F(v)$. The strategy structure of the auction can be summarized as follows:

- The minimum initial bid equals zero (i.e. there is no reservation price for the seller).[29]
- A player can place a single bid $b_i^t$ at any time $t \in T = \{0\} \cup \{t_1(m) = \frac{m}{m+1}; m = 1, 2, \dots\} \cup \{1\} \cup \{t_2(m) = \frac{2m+1}{m+1}; m = 1, 2, \dots\} \cup \{2\}$. If a player $i \in N$ at some time $t \in T$ does not bid, then we denote her bid as $b_i^t = \emptyset$. This formulation states that the auction game has four periods, two of which are divided in an infinite and countable number of subperiods. This resembles the bidding timeline of ComprasNet, see Figure 1. Every new bid of a player has to be higher than her last nonempty bid, i.e. $b_i^{t'} > b_i^t$ if $t' > t$ for $b_i^{t'} \neq \emptyset$ and $b_i^t \neq \emptyset$. At any given time $t \in T$, players can submit bids simultaneously without knowing what other bids are placed. The bid history at some time $t$ lists all the bids placed up to that time along with the identities of the bidders. The auction ends either at the end of time $t = 1$ with probability $h \in (0, 1)$ or at the end of time $t = 2$ with the remaining probability, $1 - h$.
- Depending on the ending time realization $\bar{t}$, the highest bidder wins the auction paying the highest submitted bid from another bidder according to the bid history and the last bids placed at $\bar{t}$ (if any).
- A bidder who wins the auction at some price $p$ earns $v_i - p$, a bidder who does not win earns 0.
- A player has time to react to another player's bid at any time $t \in T \setminus \{1, 2\}$, however the reaction can not be instantaneous. Any reaction $b_i^{t'}$ to a bid $b_j^t$ for $i \neq j$ can arrive earliest at $t' = t_1(1)$ if $t = 0$, or at $t' = t_1(m + 1)$ if $t = t_1(m)$ for some $m$, or at $t' = t_2(m' + 1)$ if $t = t_2(m')$ for some $m'$.
- Equal bids from different bidders are resolved by order of arrival (first bidder to submit has priority) or, if they were simultaneously submitted, at random with equal probability.

[29] For any seller's reservation price $r \in (0, \bar{v})$, the results do not change.

- Any bid submitted at $t \in T \setminus \{1, 2\}$ is transmitted with certainty.
- A bid submitted at time $t = 2$ is successfully transmitted with probability $0 < q < 1$, where $q$ is an exogenously given probability.
- Similarly, a bid submitted at time $t = 1$ arrives at the end of $t = 1$ with probability $q \in (0, 1]$. If the auction does not end at $t = 1$, and the bid does not arrive at $t = 1$, then it arrives at $t_2(1)$[30]. This is a crucial difference between the last-minute bid at $t = 2$ and (possibly) a last-minute bid at $t = 1$.

We search for equilibria that display late bidding, and more importantly sniping. Sniping will be referred to as a situation in which a player places a bid that cannot be retaliated against. In our game, conditional on the game ending at $t = 2$, a bid successfully placed at $t = 2$ is a snipe. Similarly a bid successfully placed at $t = 1$ may be a snipe with probability $h$. We show by construction that there may exist equilibria with sniping at $t = 2$ in the presence of a random ending time. Before we state the main result consider the subgame at $t = 2$.

**Theorem A.1.** *There may exist symmetric perfect Bayesian equilibria where bidders with valuation above a threshold $p \in [0, \bar{v})$ snipe each other mutually at $t = 2$ and do not place any bids in $(0, 2)$.*

*Proof.* Without loss of generality, consider the case of 2 bidders. Then the following strategies comprise the equilibrium profile. There exists a cutoff bid $p \in [0, \bar{v})$ such that the following strategy profile (S1, S2) along with the beliefs form a perfect Bayesian equilibrium,

S1. If $v_i \leq p$, then she bids $b_i^0 = v_i$ and never updates after time $t = 0$, i.e. $b_i^t = \emptyset$ for all $t > 0$.

S2. If $v_i \geq p$, then she bids $b_i^0 = p$ at time $t = 0$. If the opponent has bid $b_j^0 < p$ then she bids $b_i^{t_1(1)} = v_i$. Otherwise, she does not update until $t = 2$, i.e. $b_i^t = \emptyset$ at any $t \in (0, 2)$. At $t = 2$ she bids $b_i^2 = v_i$. If $i$ observes that $b_j^0 > p$ or $b_j^t \neq \emptyset$ at some $t \in (0, 2)$, then she bids $b_i^{t'} = v_i$ at the next possible period.

[30] This implies that the other bidders have opportunity to reply to a bid placed at $t = 1$ with probability $1 - h$, i.e. the probability that the auction ends at $t = 2$.

The condition for the equilibrium to exist is given by

$$(\bar{v} - p)\left[\frac{F(p) + q}{1 + q} - \frac{h \cdot q}{1 - h}\frac{(1 - F(p))}{(1 - q^2)}\right] \geq \int_p^{\bar{v}} F(v)dv$$

See Celiktemur and Szerman (2014) for further details on the proof.

□

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