

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

Claudio Ferraz<sup>†</sup>  
PUC-Rio

Frederico Finan<sup>‡</sup>  
UC Berkeley

Dimitri Szerman<sup>§</sup>  
PUC-Rio

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## Abstract

Firms in the developing world exhibit much flatter life-cycle dynamics compared to firms in developed countries. This paper examines the role of demand constraints in limiting the growth of small and medium firms in Brazil. We test 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. 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 winning more future auctions, as well as penetrating other markets.

*Keywords: Firm growth, Demand shocks, Government purchases*

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<sup>†</sup>Department of Economics, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), Rua Marquês de São Vicente, 225- Gávea Rio de Janeiro, RJ, 22453-900, Brasil. Email: cferraz@econ.puc-rio.br; and BREAD

<sup>‡</sup>Department of Economics, 508-1 Evans Hall, Berkeley, California 94720-3880. Email: ffinan@econ.berkeley.edu; and BREAD, IZA, NBER

<sup>§</sup>Núcleo de Avaliação de Políticas Climáticas, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), Estrada Gávea, 50 - Gávea, Rio de Janeiro, RJ, 22451-063, Brasil. Email: dimitri.szerman@cpirio.org; and Climate Policy Initiative

# 1 Introduction

Most firms in developing countries start off small and grow little over their life-cycle (e.g. [Hsieh and Klenow \(2014\)](#)). This observation has spurred a large literature investigating the barriers to firm growth in the developing world, with much of the focus on a combination of fixed costs, frictions that prevent the adoption of efficient technology, and government regulation.<sup>1</sup> Surprisingly, the demand constraints faced by small and medium firms have received much less attention. Smaller firms often lack access to larger markets and struggle to build reputation for their products.<sup>2</sup>

This paper examines the role of demand constraints in limiting the growth of small and medium firms in Brazil. We use a large employer-employee dataset combined with information on online auctions for off-the-shelf goods procured by Brazil's government to estimate whether firms that win government contracts grow more compared to firms that compete for these contracts, but win less. Because younger firms are more prone to demand constraints, we also assess whether the effect of winning these contracts vary according to firm age.

To address the endogeneity of winning government contracts, we introduce a novel research design where we use firms that lose a close auction for a procurement contract as a counterfactual for firms that win a close auction.<sup>3</sup> Typically, firms that win auctions can have very different characteristics or valuations compared to firms that lose. But in our setting, two institutional features allows us to make this comparison. First, unlike most auctions that end at a predetermined time (or based on a predetermined rule), the auctions carried out by Brazil's federal government have a random ending within a 30 minute window. Neither firms nor the auctioneer know when exactly the auction will end. Second, firms must enter their bids manually (i.e. there is no proxy-bidding system) and will routinely outbid each other several times until the auction ends at random. Thus, firms competing in close auctions might not have time to place a new bid even if they had wished to do so. 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 difference between the winning bid and the second-

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<sup>1</sup>See [Banerjee and Duflo \(2005\)](#) and [Hsieh and Olken \(2014\)](#) for an overview of these theories. For evidence on the barriers to firm growth, see for example [Banerjee and Duflo \(2014\)](#) on the difficulties that firms face in accessing finance; and [Bloom et al. \(2013\)](#) on the effects of adopting better management practices. See [Beck et al. \(2005\)](#) for how institutional constraints are related to firm growth.

<sup>2</sup>See for example [Macchiavello and Morjaria \(2015\)](#) on the importance of reputation for firms in developing countries, [Allen \(2014\)](#) on the difficulties producers face to learn about market conditions, and [Atkin and Donaldson \(2015\)](#) on estimates of intra-national trade costs. The importance of some of these channels are highlighted in [Bloom et al. \(2014\)](#).

<sup>3</sup>The empirical strategy is similar, in spirit, to [Greenstone and Moretti \(2003\)](#).

place bid is only a tiny fraction of the contract amount (e.g. in many auctions the difference is less than 0.001 percent). We show that winning these types of close auctions can be considered as good as random and that winning firms are similar to losing firms. We then use the winning of these close auctions as an exogenous demand shock to the firm and examine how firms change their employment decisions over time.

We implement the estimation by combining 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.<sup>4</sup> Every year, around 30 thousand firms participate in these auctions, through which the Federal government procures 1 million lots worth 0.7 percent of Brazil's GDP in contracts. 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 data sets 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.<sup>5</sup>

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. 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<sup>th</sup> percentile of the distribution. Despite the length of most contracts being from six months to one year, the effects persist over time as firms experience growth for at least 2 years after winning a contract. Finally, we find the increases in firm size to be larger for younger firms (even conditioning on firm size) consistent with a demand shock alleviating the constraints for firms that might have a lower market access and less reputation in the marketplace.

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

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<sup>4</sup>Starting in 2005, bidding on all federal procurement contracts had to be done via an Internet portal, called *ComprasNet*.

<sup>5</sup>A significant share of government purchases around the world is done through public procurement. 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.

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 significantly more contract winnings. 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.

Finally, we exploit our employer-employee dataset to follow workers over time as they switch firms or enter in and out of the formal labor market. We decompose the firm growth into hirings and firings and further examine whether 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.

In addition to the papers cited above, our study is related to three strands of literature. First, we contribute to a growing literature that examines the constraints faced by firms in poorer countries and what types of interventions are most effective to alleviate these constraints. The vast majority of existing studies focus on interventions that target microenterprises by providing inputs or training.<sup>6</sup> Our paper complements this literature by focusing on how demand shocks can help small and medium firms grow and generate employment opportunities that are not based on self-employment.

Second, by examining the role government plays in affecting firm growth, our paper relates to a long-standing debate on whether industrial policy can spur employment creation, innovation, and firm growth. Governments throughout the world have adopted various policies such as subsidized and targeted credit, training, production reservations, and place-based interventions. The motivation being that governments should help firms, sectors, or localities where externalities are present due to economies of scale (see [Harrison and Rodríguez-Clare \(2010\)](#) for a review of industrial

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<sup>6</sup>See for example [de Mel et al. \(2008\)](#), [Blattman et al. \(2014\)](#), [Mel et al. \(2014\)](#), [Fafchamps et al. \(2014\)](#), [Bandiera et al. \(2015\)](#). See also [McKenzie and Woodruff \(2015\)](#) who provide evidence of the importance of business practices for small firms in developing countries, [McKenzie and Woodruff \(2014\)](#) for a survey on the effects of business training for small entrepreneurs, and [Fischer and Karlan \(2015\)](#) for a discussion of the complementarities needed to sustain firm growth in the developing world.

policies in developing countries). Despite their prevalence, most of the existing evidence on the effectiveness of such policies comes from either innovation and investment subsidies to firms or place-based policies in rich countries (e.g. [Criscuolo et al. \(2012\)](#), [Freedman \(2013\)](#), [Cerqua and Pellegrini \(2014\)](#), [Kline and Moretti \(2014\)](#), and [Moretti et al. \(2014\)](#).) Our work is one of the few to credibly evaluate how demand-based policies affect firm growth in a developing country.<sup>7</sup> Also, by showing that government policies can help firms learn about their capabilities, our paper highlights another important benefit of industrial policy that has been recently argued by [Rodrik \(2007\)](#).

Finally, our paper contributes to a new literature that examines the role of demand shocks in explaining firm growth. [Syverson \(2011\)](#) suggests that demand can play an important role in explaining productivity and firm dynamics. Although there is a burgeoning theoretical literature that focuses on the role of demand to explain firm dynamics (e.g. [Arkolakis et al. \(2014\)](#), [Gourio and Rudanko \(2014\)](#), [Drozd and Nosal \(2012\)](#)), empirical evidence is still lagging behind. We view our work as complementary to [Pozzi and Schivardi \(2012\)](#) and [Foster et al. \(2012\)](#) who highlight the importance of demand factors and shocks in explaining firm dynamics. Our work is also related to [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.

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.

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<sup>7</sup>Few exceptions are [Martin et al. \(2014\)](#) and [Rotemberg \(2014\)](#) who examine the effects of product reservations in India and [Aghion et al. \(2012\)](#) who study the interaction of industrial policy and competition in China.

## 2 Background

### 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.<sup>8</sup> Starting in 2005, it became mandatory for federal agencies to procure off-the-shelf goods through reverse auctions and to conduct them online using the ComprasNet platform. ComprasNet is 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, for example, 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 government contracts that supply a variety of 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.<sup>9</sup> 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 it 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 over the internet. The tender document is free to download anonymously and contains a detailed description of each lot,

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<sup>8</sup>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 such as road construction do not. For a detailed description of public procurement in Brazil, see [World Bank \(2004\)](#).

<sup>9</sup>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.

the date of the session, reservation prices and the contract's terms and conditions.

## 2.2 The Auction Mechanism

The auctions that occur in the ComprasNet platform have two features that are central to our empirical strategy. First, they follow a sudden termination rule where, within time limits, the auctions end at random. Similar type of auctions, also known as "candle auctions", were used as early as the 14th century in France and Great Britain. In these auctions bids were only permitted as long as a burning candle did not die so the auction termination was random.<sup>10</sup>

To explain how the random ending works in ComprasNet auctions, Figure 1 depicts the bidding timeline of a typical auction. Interested firms must submit a 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.<sup>11</sup>

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.<sup>12</sup>

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 complaints 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

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<sup>10</sup>See [Cassady \(1967\)](#) and [Füllbrunn and Sadrieh \(2012\)](#).

<sup>11</sup>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 these typos.

<sup>12</sup>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.

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 the ComprasNet 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 minimum bid decrement<sup>13</sup>, 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:

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

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:

$$g_{it} = \beta_0 + \beta_1 D_{it} + \delta X_{it} + \varepsilon_{it} \quad (2)$$

where the error term  $\varepsilon_{it} = U_i + \varepsilon_{it}$  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,  $G_{it}$ :  $D_{it} = G_{it} + P_{it}$ .

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<sup>13</sup>To be precise, the minimum bid decrement is R\$0.01, which is negligible.



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:  $\varepsilon_{it} = U_i + P_{it} + \varepsilon_{it}$ .

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 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**

### **3.1.1 Theoretical considerations**

In this section, we present the theoretical grounds that allow us to credibly use the variation from close auctions to identify the effects of winning a government contract. We define a close auction as any auction in which both the winner and the loser outbid each other by small amounts in the last moments preceding the (random) time limit of the auction. The idea is to select those auctions where firms use an incremental bidding strategy towards the end of the auction. If firms do not know with certainty when the auction will end, an incremental bidding strategy at the end of auction means that there is randomness in the final ranking of bidders. Thus, in those auctions the winner and the loser should be identical ex-ante in all relevant dimensions. In particular, the winner's and runner-up's valuations should be similar. The standard English Auction in general has the property of allocating the good to the firm with the highest valuation, see [Krishna \(2010\)](#). Therefore, an important question about our research design is: are there equilibria in ComprasNet auctions able to generate close auctions where two firms with different valuations are equally likely to win the

auction?

To answer this question, [Szerman \(2012, chapter 2\)](#) develops a stylized model that captures the key elements of bidding behavior in ComprasNet auctions.<sup>14</sup> Besides the random ending, a key feature of this model, as in [Ockenfels and Roth \(2006\)](#) model of eBay auctions, is a friction in the bidding technology that gives rise to a positive probability that bids are not transmitted. In ComprasNet, the absence of a proxy bidding system creates such a friction, as bidders need time to respond to their opponents' bids; and even in eBay there are delays due to Internet traffic and connection times, which may cause bids to arrive late ([Roth and Ockenfels, 2002](#)). Towards the end of the auction, these frictions matter because when some bids are not transmitted, the winning price is effectively higher, causing expected surplus to be transferred from the auctioneer to bidders.

This model generates two types of equilibria. In one, all bidders bid up to their true valuations before the random phase starts. These equilibria are equivalent to the standard equilibrium in weakly dominant strategies of an English Auction. Once the random phase starts, there is no further bidding and the firm with the highest valuation wins. Under these types of equilibria we will not observe two firms trying to outbid each other during the random phase. Therefore, the data generated by these equilibria are not part of our sample of close auctions. The second type of equilibria is where firms outbid each other by tiny amounts until the auction randomly ends, therefore trading off the probability of winning for a better price conditional on winning. These equilibria arise because of the frictions in the bidding technology, which give bidders incentives to avoid an early price war and engage in incremental bidding during the random phase.<sup>15</sup> This is the bidding behavior that gives rise to the close auctions we use.<sup>16</sup>

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<sup>14</sup>[Szerman \(2012, chapter 2\)](#) extends [Ockenfels and Roth \(2006\)](#) model of eBay auctions by replacing the fixed ending time with a random ending time. It is important to note that ascending auctions are complex dynamic games, and generally cannot be fully analyzed with available methods. Such complexity has led researchers to rely on abstractions for tractability, modeling ascending auctions as a “button auctions”, as in [Milgrom and Weber \(1982\)](#). Time limits bring additional difficulties in modeling ascending auctions by augmenting bidders' strategy space. As a result, any attempt to model ascending auctions with time limits is bound to be a drastic simplification of reality, aimed at capturing only the most salient features of the auction game.

<sup>15</sup>[Szerman \(2012\)](#) show that such equilibria 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.

<sup>16</sup>For tractability, the model implicitly assumes that all firms have access to the same bidding technology, effectively ignoring the possibility that some firms may place bids faster than others. This simplifying but important assumption is however testable with the data we have, and in section 4 we confirm that winners' and losers' bidding behaviors and characteristics in close auctions are not distinguishable.

### 3.1.2 Empirical implementation

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

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

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 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.<sup>17</sup> Using this variation, we can measure the causal effects by estimating the following model by TSLS:

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

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

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,

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<sup>17</sup>This approach is similar to the one used by [Rehavi \(2007\)](#) to assess the effects of female legislators on public spending.

i.e.  $Z_{it} = V_{it}^{\text{win close}} / (V_{it}^{\text{lose close}} + V_{it}^{\text{win close}})$ .<sup>18</sup>  $\eta_i, \xi_i$  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.<sup>19</sup>

### 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 endogenous 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:

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

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

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<sup>18</sup>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.

<sup>19</sup>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.

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

### 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.<sup>20</sup> 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<sup>21</sup>. 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 B.1 reports statistics for the 20 most frequent product categories in the sample. As the cate-

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<sup>20</sup>See <http://www.comprasgovernamentais.gov.br/>

<sup>21</sup>The Federal Supply Codes are available at <http://www.dlis.dla.mil/H2/search.aspx>.

gories header suggests, various types of goods and services from different industries are procured through ComprasNet auctions. Categories range from books, to pharmaceutical, 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 1 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<sup>rd</sup> and 4<sup>th</sup>. 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 2 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 of 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 2, 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 B.1 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 (~ 60%) and US (~30%). 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 B.2, 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.



Recall that we showed in Table 1 that winners and runner-ups place opening bids that rank similarly, display similar response times, and place a similar number of bids in the random phase. In Table 3, 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 3 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 4 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 4. 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.<sup>22</sup> 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.<sup>23</sup>

## 5 Results

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

Table 5 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

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<sup>22</sup>Since other firms may also be participating in the auctions, these percentages need not sum up to one.

<sup>23</sup>We do not report these results in order to economize on space. They can be made available upon request.

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 5 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<sup>th</sup> 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.<sup>24</sup>

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<sup>24</sup>These results are available upon request.

## 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 6, columns 1 and 2 show that the effects of winning a government contract are much more pronounced among retail firms compared to manufacturing firms.<sup>25</sup> 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 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.<sup>26</sup> 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 3, we examine the extent to which the effects of winning a government contract vary according to the age of the firm. As in Figure B.2, we divide firms according to various 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.<sup>27</sup> In Figure 3, 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

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<sup>25</sup>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.

<sup>26</sup>Based on their initial size, the median firm in our sample had 3 employees prior to the start of the auction.

<sup>27</sup>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.

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.

### 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. In our sample, the median contract has a duration of 6 months, and the 95th percentile of the contract duration distribution is 12 months. 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 4 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 invest 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.

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.

**Learning in Auctions** Figure 5 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 7, 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 8, 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.

**Organizational upgrading** In principle, investments in organizational capital could also explain why our effects persist over time. In Figure 3, we documented that the effects of winning a con-

tract 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.<sup>28</sup> 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 9](#), 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.

## 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 10](#) we test the robustness of our main results by controlling for the participation of firms

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<sup>28</sup>These models have received recent empirical support by [Kueng et al. \(2014\)](#).



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 correct 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<sup>th</sup> 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 its 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.

To further test for endogenous selection effects, we re-estimate in Appendix Table B.2 our main specification using three alternative estimation samples. For ease of comparison, columns 1 and 2 reproduce our original OLS and IV estimates presented in Table 5. In columns 3 and 4, we restrict the sample to only those firms who ever participated in a close auction. This reduces the sample to 18,240 firms. Despite this sample restriction, the point estimates remain virtually unchanged, suggesting that our effects are not the result of any differences between firms that participated in close auctions versus those that did not.

In column 5 and 6, we consider only the firm-quarter observations in which the firm participated in at least one close auction.<sup>29</sup> Although this sample is quite restrictive, it perhaps best approximates the variation one would use if one had estimated these employment effects using an RDD at the auction level. Even based on this sample, the effects are again similar. Winning a contract increases firm growth by 5.1 percentage points, which although larger than our original effect size, reflects the fact that the demand shocks are much larger (see Table 1).

Finally, we estimate our main model restricting the sample to just the periods up to 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. In column 8, we find that winning a contract increases firm growth by 1.6 percentage points, which is a slightly smaller effect size compared to our original 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.<sup>30</sup> 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.

<sup>29</sup>Firms in this sample, on average, participated in 8 close auctions and 367 auctions in each quarter.

<sup>30</sup>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.

In Table 11, 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 government 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 in future auctions, participate in auctions of higher values, and sell a broader set of products 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. Unfortunately, with our data we cannot test this mechanism. Also, although we emphasized a learning story about product demand, firms and customers may also be learning about the firm's product quality. 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 grow. Such policies may also be particularly relevant for younger firms, which often lack the networks and knowledge to sell in larger markets.

How is public procurement different from private procurement? First, the federal government is a better payer than most private parties. This gives vendors security, enabling them for example to hire an additional worker to fulfill a contract they know will be paid for. Second, the federal government has less discretion in choosing its suppliers than private companies. In particular, the government gives less weight to vendors' reputation than do private companies procuring goods and services.

Our findings do not necessarily imply that government purchases are an efficient way to foster growth and employment. Public procurement may give young firms – who lack market reputation – an easier access to a market. But it might give them little incentive to improve their reputation through quality upgrading, productivity, or on-time delivery. We cannot test any of these possibilities with the data we currently have, but we believe these are important questions for future research. Our results are also limited because they do not take into account general equilibrium effects. 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. \(2013\)](#)). 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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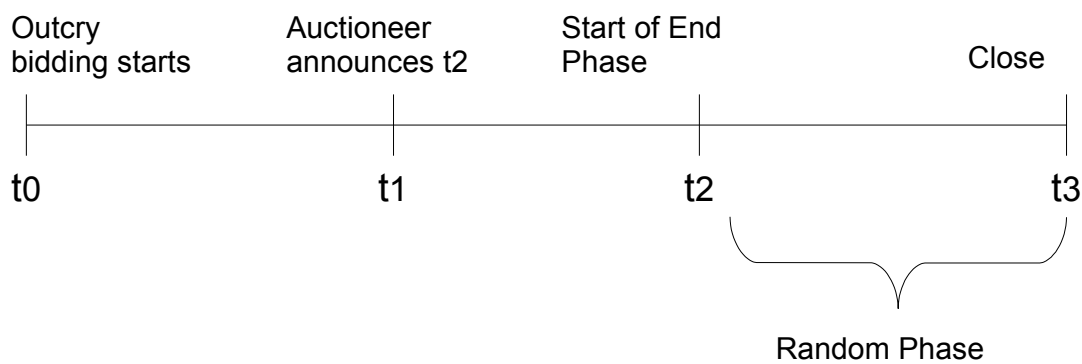


Figure 1: Bidding Timeline

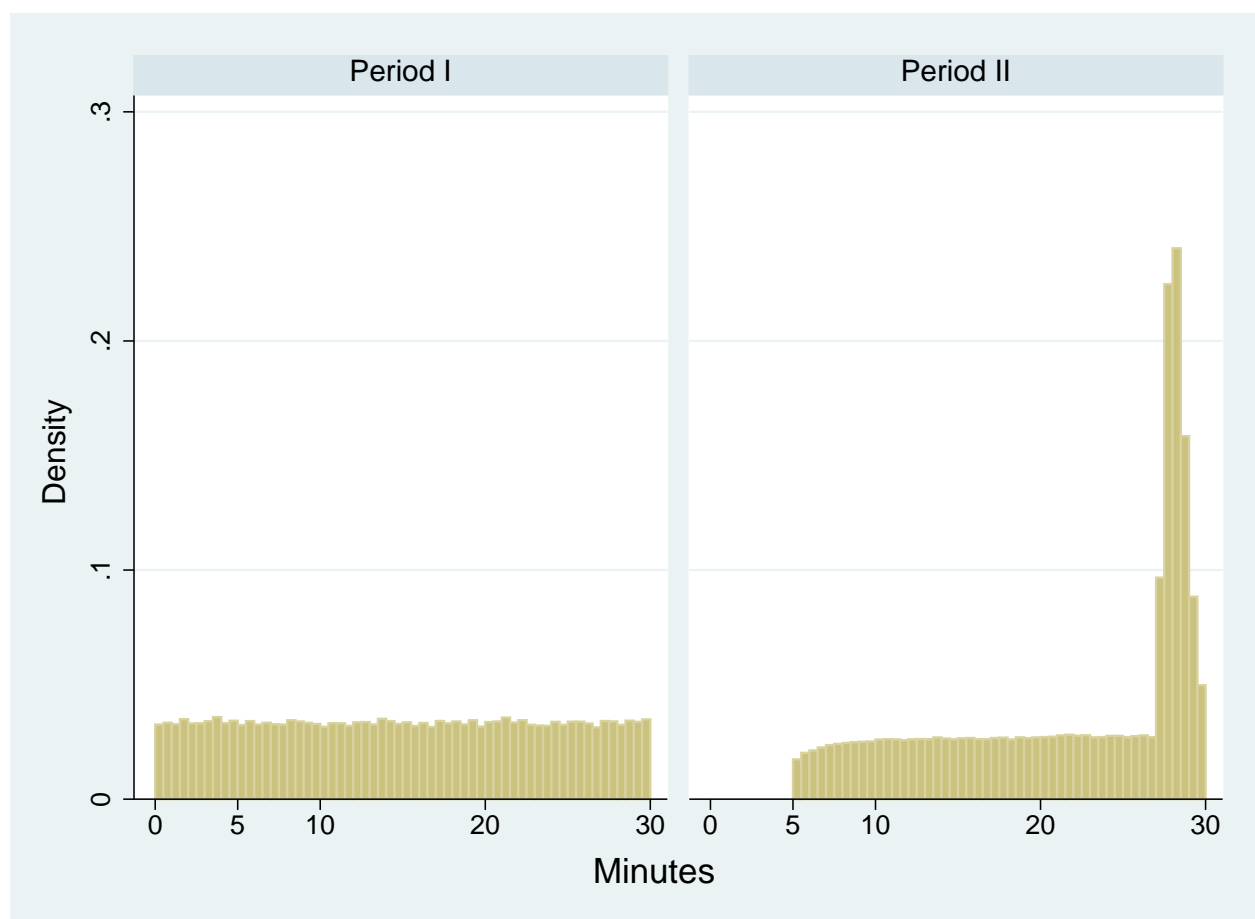


Figure 2: Distribution of Random Duration

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.

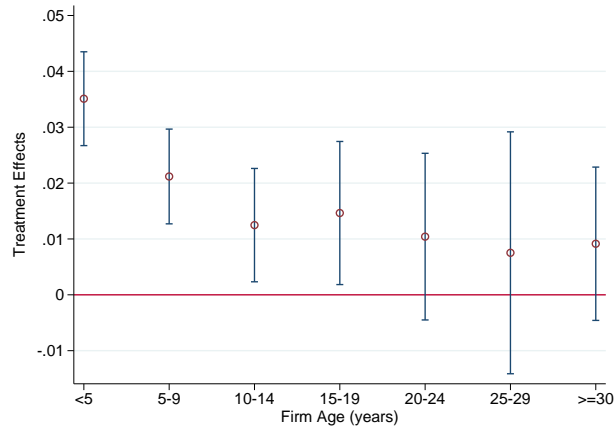


Figure 3: Treatment Effects by Firm Age

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.

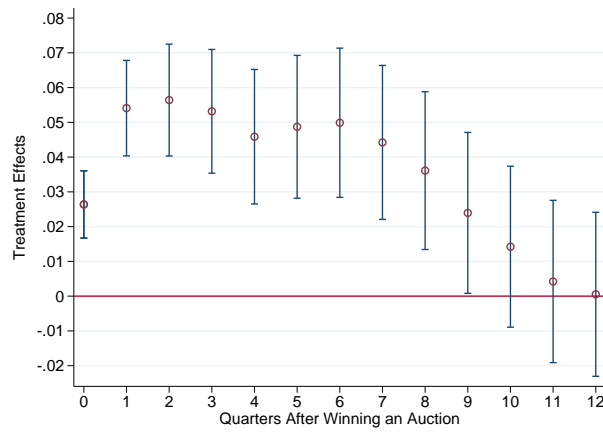
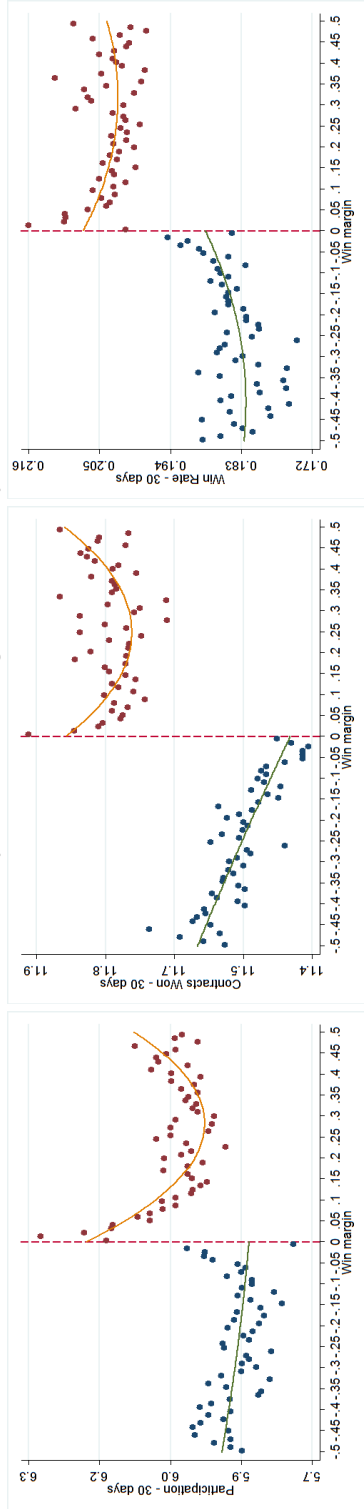


Figure 4: Long Run Effects of Winning an Auction

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



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

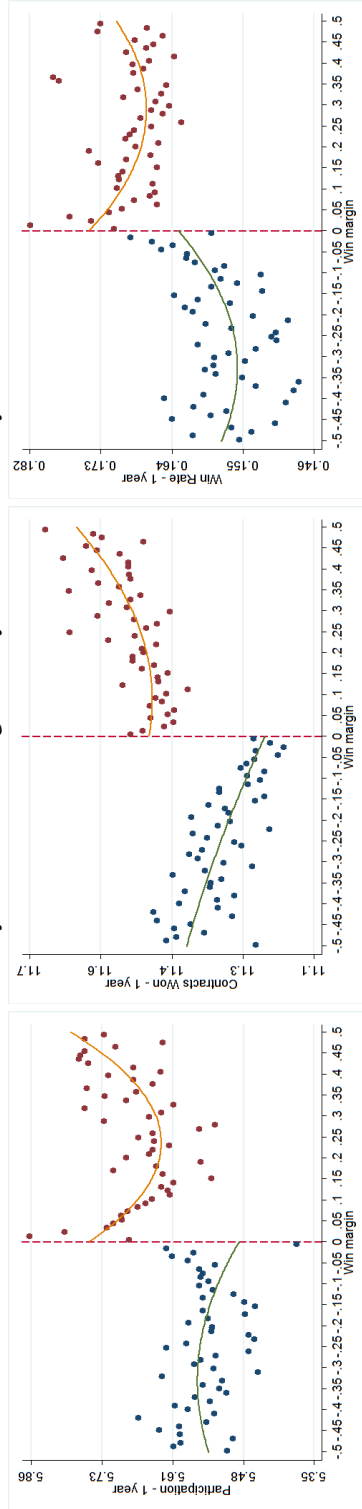


Figure 5: The Effect of Winning a Government Contract on Future Auction outcomes: RD Graphs

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: 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
$100 \times \frac{\text{Ranked2} - \text{Ranked1}}{\text{Ranked2}}$	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
<i>Auction duration</i>				
Total (minutes)	66.3	55.2	70.0	53.7
Random phase (minutes)	21.2	8.16	26.2	5.90
<i>Number of bids</i>				
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
<i>Response Time to rivals' bids in random phase (seconds)</i>				
Winner's response	30.2	20.7	18.1	11.1
Runner-up's response	36.7	25.2	21.6	13.0
<i>Rank of first bid placed</i>				
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
<i>Geographic region of public body</i>				
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 RS.

Table 2: Sample Descriptive Statistics: Firms

	Firms Participating in Auctions		All Firms	
	Mean	Std. Dev.	Mean	Std. Dev.
<i>Number of employees</i>				
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
<i>Number of new hires</i>				
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
<i>Employees' Characteristics</i>				
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
<i>All auctions...</i>				
Participated	31.5	268.5		
Won	4.80	58.3		
Winnings (R\$1,000)	183.2	130350.9		
<i>Close auctions...</i>				
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 3: Winners vs Runnerups: Sample Balance

	Runnerups		Winners		p-value
	Mean	Std. Dev	Mean	Std. Dev	
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

Notes: Table shows means and standard deviations of selected variables for winners and runnerups of close auctions, for different definitions 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 4: 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 actual auction durations by 5 seconds. The other rows are analogous.

Table 5: 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 [0.001]				0.022 [0.002]			
Amount Won (logs)		0.001 [0.000]				0.002 [0.000]		
Won a close auction			0.016 [0.001]				0.697 [0.002]	
Share of close auctions won				0.013 [0.002]				7.686 [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 6: 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 [0.006]	0.023 [0.002]	0.026 [0.003]	0.023 [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 7: 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)
<i>Panel A: Winnings in participated auction (log)</i>									
Winner	0.579 [0.045]	0.593 [0.048]	0.643 [0.059]	0.530 [0.041]	0.544 [0.043]	0.588 [0.053]	0.337 [0.084]	0.341 [0.090]	0.342 [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
<i>Panel B: Number of auctions participated (log)</i>									
Winner	0.393 [0.031]	0.411 [0.033]	0.468 [0.041]	0.397 [0.032]	0.414 [0.034]	0.466 [0.042]	0.194 [0.052]	0.200 [0.056]	0.212 [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
<i>Panel C: Win rate</i>									
Winner	0.017 [0.004]	0.017 [0.005]	0.016 [0.006]	0.015 [0.004]	0.015 [0.005]	0.014 [0.006]	0.008 [0.003]	0.008 [0.003]	0.007 [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
<i>Panel D: Winnings/Number Won</i>									
Winner	0.046 [0.014]	0.045 [0.015]	0.042 [0.018]	0.032 [0.018]	0.030 [0.019]	0.028 [0.023]	-0.011 [0.020]	-0.012 [0.021]	-0.016 [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 polynomial	Linear Spline	Cubic spline	Cubic polynomial	Linear Spline	Cubic spline	Cubic polynomial	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, controlling 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 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)
<i>Panel A: Share of participated auctions in the same city</i>									
Winner	-0.025 [0.002]	-0.025 [0.003]	-0.026 [0.003]	-0.024 [0.002]	-0.025 [0.002]	-0.027 [0.003]	-0.019 [0.003]	-0.019 [0.003]	-0.018 [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
<i>Panel B: Number of different product codes</i>									
Winner	5.8 [0.9]	6.0 [1.0]	7.1 [1.1]	7.7 [1.2]	8.0 [1.2]	9.4 [1.4]	1.9 [0.4]	1.9 [0.4]	2.1 [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
<i>Panel C: Share of auctions in the top product code</i>									
Winner	-1.8917 [0.2679]	-1.9890 [0.2810]	-2.3142 [0.3333]	-1.5990 [0.2622]	-1.6926 [0.2738]	-2.0302 [0.3205]	-0.8402 [0.2411]	-0.8735 [0.2557]	-0.9009 [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
<i>Panel D: Share of auctions in the top 3 product codes</i>									
Winner	-2.0410 [0.3035]	-2.1623 [0.3178]	-2.6537 [0.3786]	-1.9097 [0.3005]	-2.0215 [0.3134]	-2.4660 [0.3692]	-1.0062 [0.2606]	-1.0664 [0.2778]	-1.2840 [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 polynomial	Linear Spline	Cubic spline	Cubic polynomial	Linear Spline	Cubic spline	Cubic polynomial	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, controlling 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 Government Contract on Employee's years of schooling

	(1)	Firm Age (years)				
		(2) <5	(3) 5-9	(4) 10-14	(5) 15-19	(6) 20+
Won	0.025 [0.014]	0.042 [0.025]	0.058 [0.023]	-0.016 [0.028]	-0.007 [0.034]	0.043 [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 10: The Effects of Winning a Government Contract on Firm Growth: Controlling for Selection

	Dependent Variable: Employment Growth				
	(1)	(2)	(3)	(4)	(5)
<i>Panel A</i>					
Won	0.026 [0.005]	0.024 [0.006]	0.029 [0.005]	0.026 [0.007]	0.029 [0.004]
Inverse Mill's ratio	-0.001 [0.003]	-0.001 [0.003]	-0.002 [0.003]	-0.002 [0.003]	
<i>Panel B</i>					
Amount Won (logs)	0.002 [0.000]	0.001 [0.001]	0.002 [0.000]	0.002 [0.001]	0.002 [0.000]
Inverse Mill's ratio	-0.001 [0.002]	-0.001 [0.002]	-0.002 [0.002]	-0.001 [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 5 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 11: Decomposing the Effects on Firm Growth: Hires and Layoffs

	(1) Growth	(2) Layoffs	(3) Total	(4) Yes	(5) Total	(6) New Hires	(7) From Other Firms?	(8) No	(9) No
						How many quarters out of the Labor Market?			
						1	2	3	4+
Won a contract	0.0223 [0.0020]	0.0047 [0.0012]	0.0272 [0.0017]	0.0020 [0.0006]	0.0252 [0.0015]	0.0022 [0.0004]	0.0039 [0.0005]	0.0033 [0.0004]	0.0158 [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 into 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 A: 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).<sup>31</sup>
- 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.
- 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  $q$

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<sup>31</sup>For any seller's reservation price  $r \in (0, \bar{v})$ , the results do not change.

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  $t_2(1)$ <sup>32</sup>. 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.

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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<sup>32</sup>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  $t = 2$ .

# B Appendix B

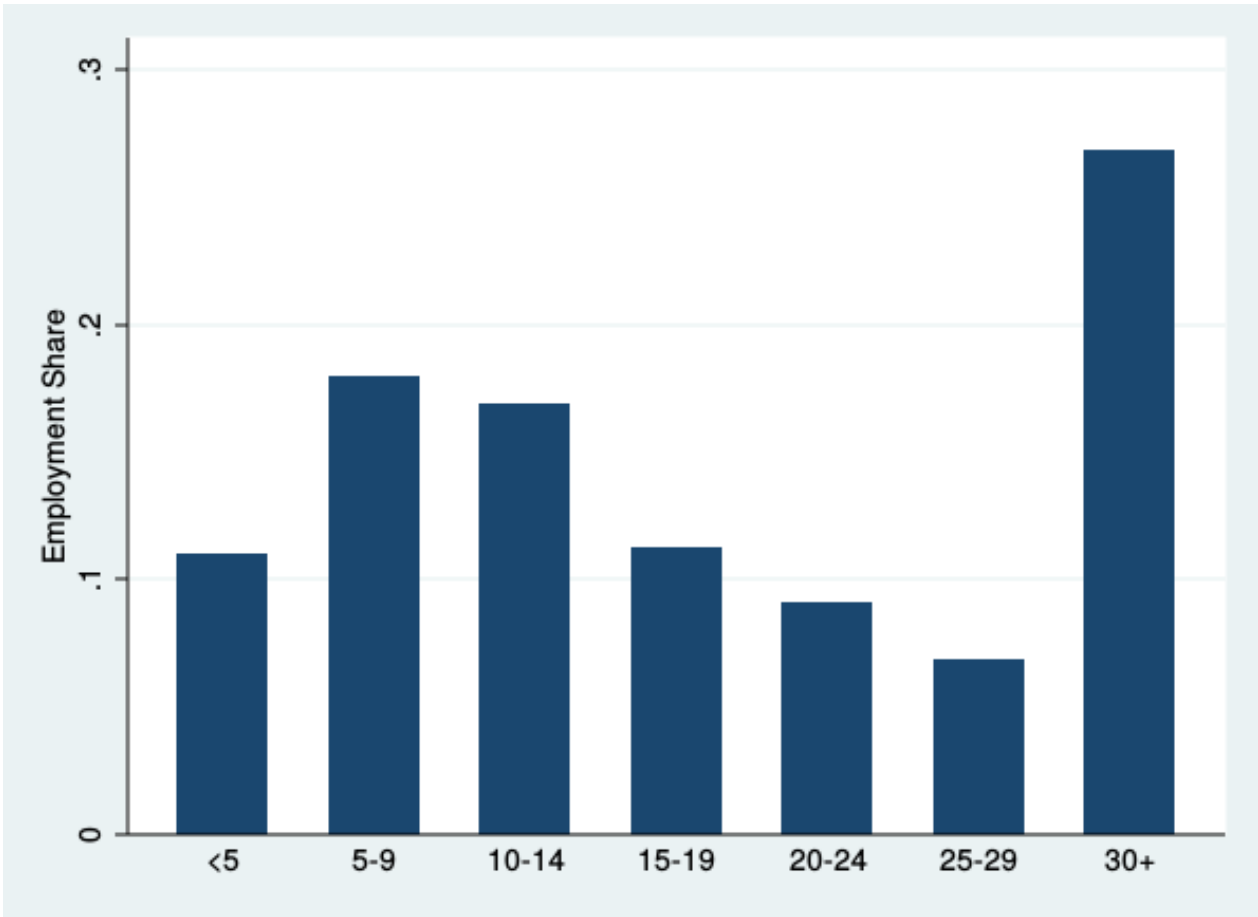


Figure B.1: Formal employment by Firm Age

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.



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

	(1)	(2)	(3)	(4)	(5)	(6)
	# of Lots	% of Total	Median Lot Estimate	% of Total Value Purchased	# of 4-digit	# 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.

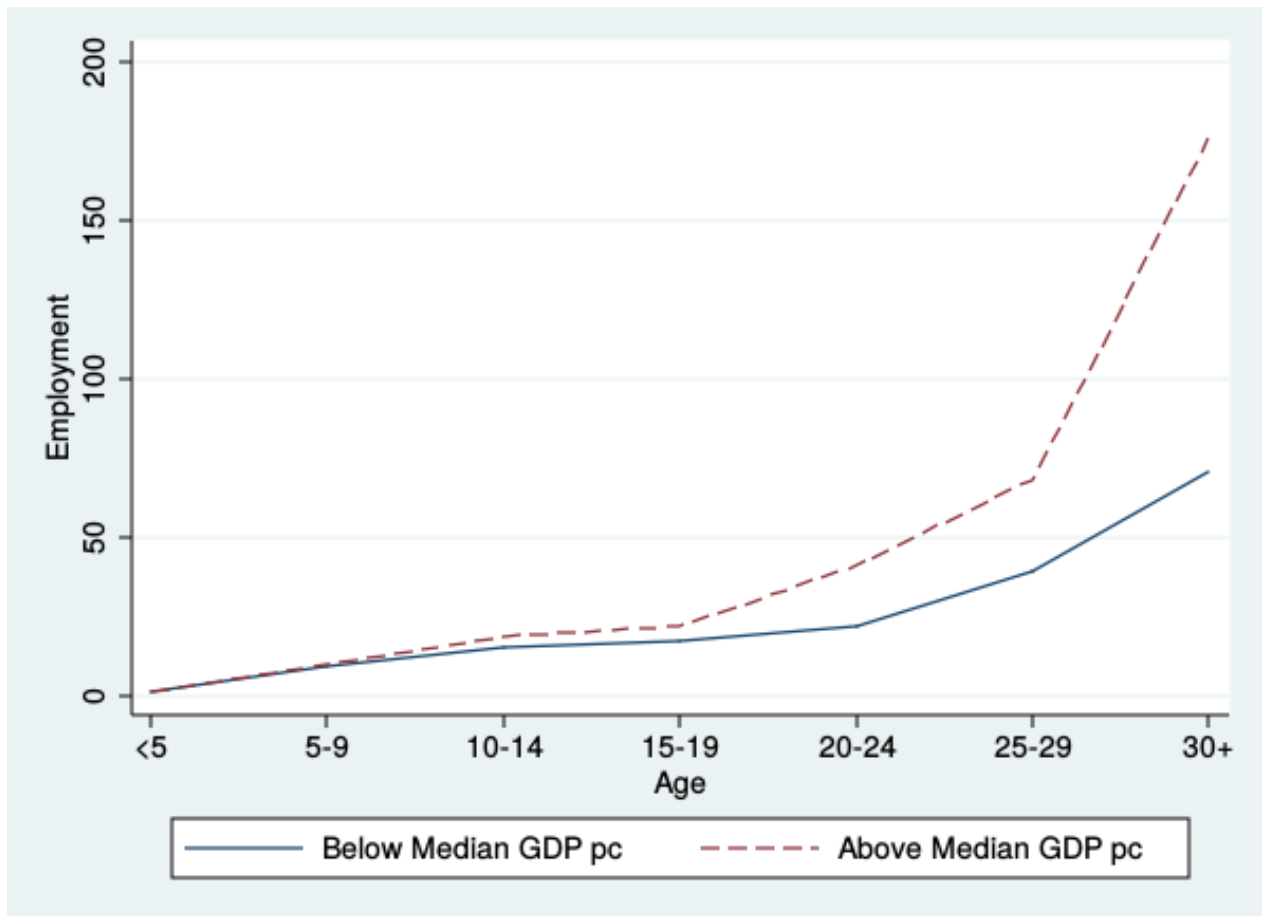


Figure B.2: Firm Size by Age

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.

Table B.2: The Effects of Winning a Contract on Firm Growth

Sample Definition	Full Sample		Restriction 1		Restriction 2		Restriction 3	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV
Won	0.010 [0.001]	0.022 [0.002]	0.012 [0.001]	0.023 [0.002]	0.014 [0.005]	0.051 [0.019]	0.008 [0.002]	0.016 [0.004]
$R^2$	0.052	.	0.052	.	0.198	.	0.069	.
Observations	962,531	962,531	409,938	409,938	58,163	58,163	708,390	708,390
Mean dep. var.	0.024	0.024	0.025	0.025	0.032	0.032	0.031	0.031

Notes: All specifications include firm fixed effects and quarter dummies. Standard errors clustered by firm in brackets. The dependent variable in all columns is firm growth in the current quarter. In columns 1 and 2, we replicate our baseline results, shown in Table 5. In columns 3 and 4 we restrict the sample to the 18,240 firms who ever participated in a close auction. In columns 5 and 6, we further restrict the sample to those firms-quarter that participated in at least one close auction. Because of firms fixed-effects, we are forced to exclude 7,259 firms that participate in close auctions only in one quarter. In columns 7 and 8 we restrict the sample to firm-quarters up to and including the first auction won. 814 firms that never win an auction are excluded.