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Demand Aggregation and Credit Risk Effects in Pooled Procurement:Evidence from the Brazilian Public Purchases of Pharmaceuticals and Medical Supplies

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Demand Aggregation and Credit Risk Effects in Pooled Procurement: Evidence from the Brazilian Public Purchases of Pharmaceuticals and Medical Supplies*

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Abstract

Pooled procurement has an important role in reducing acquisition prices of goods. A pool of buyers, which aggregates demand for its members, increases bargaining power and allows suppliers to achieve economies of scale and scope in the production. Such aggregation demand effect lowers prices paid for buyers. However, when a buyer with a good reputation for paying suppliers in a timely manner is joined in the pool by a buyer with bad reputation may have its price paid increased due to the credit risk effect on prices. This will happen because prices paid in a pooled procurement should reflect the (higher) average buyers' credit risk. Using a data set on Brazilian public purchases of pharmaceuticals and medical supplies, we find evidence supporting both effects. We show that the prices paid by public bodies in Brazil are lower when they buy through pooled procurement than individually. On the other hand, federal agencies (i.e. good buyers) pay higher prices for products when they are joined by state agencies (i.e. bad buyers) in a pool. Such evidence suggests that pooled procurement should be carefully designed to avoid that prices paid increase for its members.

Keywords: Pooled Procurement, Acquisition Prices, Demand Aggregation, Risk Effect, Pharmaceuticals and Medical Supplies

JEL codes: H5, H51, H57, I18

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1 Introduction

Since the last decade, organizations in several countries have established framework agreements in order to jointly procure for goods and services with selected suppliers. The idea is to benefit from purchasing synergies (Karjalainen, Kemppainen and Van Raaij (2009)). It means that instead of each organizational unit or even individual employees deciding upon their own specifications, suppliers, and contractual agreements, and running the processes associated with this in parallel, searching for suppliers when a purchasing need arises, organization-wide agreements are made with a selection of preferred suppliers. Such arrangements are commonly named Pooled Procurement.[1]

Consistent with this trend, many institutional changes have been recently made by the European Commission (EC) in order to reorganize public procurement in Europe. In particular, the EC Directive 18/2004 established a uniform and harmonized legislation for conducting public procurement, aiming at promoting pooled procurement in Europe through framework agreements (FAs).[2] Since then, FAs have started to be widespread adopted in several European countries. For instance, Bandiera, Pratt and Valletti (2009) document that the value of purchases made by Consip with Italians public bodies via FAs reached 22 % of total Italian procurement expenditures in 2005.[3]

Such trend in public procurement is not only prevalent in the European countries. In the U.S., for instance, similar agreements for the acquisition of pharmaceuticals have become very common amid the U.S. states.[4] According to NCSL (2010), since 1999 several U.S. states have enacted laws and executive orders authorizing public entities to organize bulk purchasing of pharmaceuticals.[5] Latin American countries (Brazil, Peru and Chile), India and New Zealand have also similar experiences.[6]

[1]The literature sometimes names such arrangement as Bulk Purchasing or Bulk Procurement.

[2]In England, Local Government Acts (1972, 1988 and 2002) transfered the provision and regulation of local public goods, works and services to local governments, and also encourage them to join effort, through consortium, to share administrative experience and acquire such goods and services jointly.

[3]Karjalainen (2010) also documents similar trend in Finland.

[4]Such arrangement is also common in the U.S. private sector. In Florida (U.S.), eleven members of the Chain Drug Consortium have formed the Chain Pharmacy Alliance (CPA) as a contractual joint venture to aggregate their generic pharmaceutical volume into one compliant program.

[5]Currently, there are five operating multi-state bulk buying pools, not counting several additional variations and single state-initiatives. They are National Medicaid Pooling Initiative(NMPI), Top Dollar Program (TOP), Sovereign States Drug Consortium (SSDC), Northwest Prescription Drug Consortium (NPDC), and Minnesota Multistate Contracting Alliance for Pharmacy (MMCAP). For more details on the Pharmaceutical Bulk Purchasing in the U.S., see NCSL (2010).

[6]Mucha (2010) documents Peruvian experience in pooled procurement of prescription drugs, and Huff-Roussell and Burnet (1996) analyze framework agreement between Caribean countries (ECDS) to procure for pharmaceuti-

It is not hard to believe that acquisition prices of goods are lower in pooled procurement than in individual ones. A pool of buyers, which aggregates demand for its members, increases bargaining power and may reduce supplier's production and logistic costs. However, one may wonder if buyers may pay higher prices when procuring goods with other buyers. How can it can happen?

In an environment where buyers have different financial capabilities and consequently different levels of timeliness in paying suppliers, pooled procurement may raise the price paid by buyers which have built good reputation with suppliers. This happens because there is a common feature in all pooled procurements, and also in the Brazilian pooled procurement system, that once the pool is formed, the auction is run and the supplier is selected, the latter is obligated to provide goods and services at a unique price to all members of the pool. So, if the pool is formed since its inception by a reputable buyer along with a buyer of bad reputation, the good buyer will pay a price that reflects both his own risk of delay payment, and the one of the bad buyer.[7]

In this paper we analyze empirically whether prices paid by buyers increase or reduce when they are joined by other buyers in procurement pools. Using a data set on Brazilian public purchases of pharmaceuticals and medical supplies, we show that the prices paid by public bodies in Brazil are lower when they buy through pooled procurement than individually, which is consistent with a demand aggregation effect.[8] On the other hand, we find that good buyers (e.g., federal agencies) pay higher prices for products when they are joined by bad buyers (e.g., state agencies) in a pool. This supports the argument that a credit risk effect may increase prices paid for some buyers of a procurement pool. Such evidence suggests that pooled procurement should be carefully designed to avoid that some buyers subsidize the purchase of others, and price paid increases for them. Otherwise welfare-enhancing pooled procurements will not be formed.

Our database contains information on purchases of 5.248 different items-products, from 2004-2009. Besides information on prices paid in pooled and individual procurement, the dataset provides full description and codification of each product purchased, information on the year of

cals. Tordoff, Norris and Reith (2005) and Chaudhury et al (2005), respectively, analyze the centralizing of hospital purchases in the New Zealand and in Delhi (India). Singer, Konstantinidis, Roubik and Beffernan (2009) estimate the gains of the centralization of public purchases in Chile.

[7]The selected supplier is able to refuse supply to a free-rider, though: if other public entities want to join the pool after the supplier is selected, they have to be authorized by both the supplier and the pool manager.

[8]In Bandiera, Pratt and Valletti (2009) setting, such aggregation demand effect is probably an additional reason for Italian local governments to prefer dealing with Consip (the public agency in charge of pooled procurement in Italy) rather than relying on individual standard procurement.

purchase, the award mechanism, the reserve price in each procurement auction, the initial demand and quantity purchased, suppliers, buyers, and the number of suppliers competing for provision of each product.

Some theoretical studies has pointed out the role of pooled procurement in reducing acquisition prices of goods. Dimitri, Dini and Piga (2006), for instance, argue that this effect increases the bargaining power of buyers, allowing them to obtain discounts for bulk buying, and to negotiate better contracts and terms for provision of goods and services. Additionally, Barbosa (2011) shows that purchases of high volume allow suppliers to achieve economies of scale and scope in the production and logistic process, thereby reducing the supplier's marginal cost. Indeed, when there is enough competition between suppliers, the price paid by buyers follows the reduction in marginal cost. Therefore, such aggregation demand effect lowers prices paid for all buyers in a pooled procurement.[9]

However, Albano and Sparro (2008) argue that pooled procurement may increase the price paid for some members of the pool. Analyzing the equilibrium price in the framework agreement game, they show that when suppliers commit to provide goods and services at unique price for horizontally heterogeneous buyers in a pooled procurement, then the equilibrium price will reflect the average heterogeneity of buyers. As a result, buyers which are close to the supplier will subsidize the buyers which are far away from him.

Besides these theoretical studies, there are very few studies that analyze empirically the benefits and drawbacks of pooled procurement. The lack of extensive data bases which allow a comparison between prices paid in pooled procurement and in individual one may explain the scarceness of studies on the topic. The existing ones use databases with aggregate measure of government expenditures to evaluate the aggregation demand effect of bulk purchasing, or use very small samples of products.

Karjalainen (2010), for instance, analyzes the prices paid by Finnish public bodies for 8 products in a pooled procurement, and compares them with the retail prices. The author finds that the unit prices paid in the pooled procurement are much lower than retail ones. A criticism that is

[9]The literature has also documented other benefits of pooled procurement. For instance, Bandiera, Pratt and Valletti (2009) show that pooled procurement reduces passive waste (mismanagement, inefficient and untrained civil servants to perform procurement talks) when the procurement process is delegated to a procurement agency. In addition, Karjalainen (2010) argues that pooled procurement avoids duplication of administrative costs, process and efforts, thereby reducing public expenses with procurement processes. Additionally, Chaudhury et al. (2005) document that pooled procurement increased substantially the quality of prescription drugs and hospital equipments at public hospitals in Delhi (India).

often made to such kind of comparison is that the retail price in not the counterfactual for pooled procurement. As a matter of fact, the retail prices are often higher, even when compared to the individual procurement of a great buyer. A rigorous econometric analysis should compare the prices paid by buyers in a pooled procurement with the prices paid for the same buyers whether they have bought the same product individually or not. That is exactly what we do in this paper.

Other studies, like Singer, Konstantinidis, Roubik and Beffernan (2009), analyze the reduction in prices paid by the public bodies due to a simultaneous adoption of pooled procurement and electronic auctions. Since both mechanisms lead to lower prices paid, these studies are not able to disentangle these confounding effects.

Differently, Huff-Roussele and Burnett (1996), analyzing the Caribbean Pooled Procurement for purchasing pharmaceutical (ECDS), document that ECDS began paying higher prices for prescription drugs when some of the pool members started delaying payment of previous purchases. This is consistent with credit risk effect that we will test in this paper.

The contributions of this paper can be divided into three different topics. First, to the best of our knowledge, it is the first article to test the demand aggregation effect arising in pooled procurement with a database containing a very large number of products, purchased both through pooled and individual procurement, and to control for observable and unobservable product, award mechanism and buyer characteristics. Secondly, it is the first work to disentangle the demand aggregation effect in pooled procurement from the effect of adopting electronic auctions, since in all observed transactions from our database auction is the unique award mechanism. Finally, it shows that not all buyers enjoy price reduction in pooled procurement. This result allows us to conclude that if pooled procurement are not well-designed, then some buyers may subsidize the purchase of other buyers, which may lead to underformation of pooled procurements.

■ **Related Literature.** Surprisingly, empirical studies which analyze the benefits and costs of pooled procurement for its members are rare. Most of the studies are in Public Health and Health Management, where pooled procurement is a common practice. Huff-Roussell and Burnett (1996), for instance, analyze the pooled procurement created by Caribbean countries to buy prescription drugs for public hospitals of their countries. Basing on aggregate measures of expenditures with prescription drugs for each country, they show that the average unit price paid by each country reduced after the country joined the Caribbean pooled procurement. Similarly, Ombaka (2009), analyzing a group procurement composed by Kenya, Uganda, England, Togo, India, Thailand,

New Zealand and others, shows that total expenses with prescription drugs in each country reduced after the creation of pooled procurement. Additionally, Tordoff, Norris and Reith (2005) study the effect of purchase centralization of prescription drugs in New Zealand's public hospital by PHARMAC. Analyzing the total expenditure of 11 hospitals in New Zealand in 612 prescription drugs, before and after PHARMAC started procuring, the authors find that procurement centralization significantly reduces hospital expenses.

In contrast, Waning et al. (2009) do not find evidence supporting that high volume of purchase reduces unit price. Using information on 7253 procurement transactions of 12 antiretrovirals and 24 different doses of these drugs from the Global Fund Price Reporting Mechanism and the WHO Global Price Reporting Mechanism (GPRM), they find weak positive relationship between price paid and the amount purchased (elasticity of demand is not statistically significant). However, the authors do not control for buyer and award mechanism characteristics, and purchase conditions (bundling, rebates and discounts). In addition, they examine price-volume relationships at the level of individual purchases and do not consider total volume-price relationships at the level of tender arrangements, as these data were unavailable. Indeed, countries usually tender once or twice a year for larger volumes that are delivered in the multiple smaller purchase volumes reported in the databases.

The paper is organized as follows. Section 2 describes the institutional aspects of public pooled procurement in Brazil (Price Registration System). Section 3 describes in details the demand aggregation and credit risk effect, and formally states the hypothesis that we test in this paper. Section 4 presents the econometric model and explain how we test the hypothesis. Section 5 describes our data base and presents some descriptive statistics of the variable that we use in our econometric analysis. In Section 6 we present the econometric results, showing how our estimations support or not the testing hypothesis. Section 7 discuss the limits of our results and suggests extensions. Section 8 concludes.

2 Institutional Background: Public Pooled Procurement in Brazil

2.1 Previous Arrangements: Procurement Laws

■ **Public Procurement in Brazil.** According to the Brazilian procurement legislation, Federal Law nº 8.666/93, any sphere of Brazilian government must use competitive tendering as a procedure to make a purchase of a good, perform a work, or acquire a service through third parties. In the Brazilian legislation, competitive bidding is defined as the administrative procedure whereby the public administrator selects, among all application submitted for the supply of works, goods or services, which one best serves the public interest, and awards to the winner the right to supply to the government.

The spheres of the Brazilian government may use the following forms of procurement for goods, works and services: (i) Open Competitive Bidding (a reverse first-price sealed-bid auction in which any supplier is allowed to submit a bid), (ii) Pre-Qualified Bidders (a reverse first-price sealed-bid auction in which only suppliers with solid track record of providing good for the government is allowed to bid), (iii) Invited Bidders (a reverse first-price sealed-bid auction in which only invited bidders are allowed to bid), (iv) Open Hybrid Competitive Bidding (a reverse first-price sealed-bid auction followed by a reverse English auction in which any supplier is allowed to submit a bid), and (v) Open Electronic Competitive Bidding (an electronic reverse English auction in which any supplier is allowed to submit a bid).[10],[11]

The value and type of product or service determines the form of procurement to be used. In general, goods, services and works of high values must be acquired through Open Competitive Bidding, while those of lower values can be acquired through Invited Bidders. For intermediate values, one can purchase them through Pre-Qualified Bidders. Open Hybrid and Electronic Competitive Bidding can be used for purchasing of standardized goods and services of any value.

[10] In the Procurement literature, summarized by Dimitri, Piga and Spagnolo (2006), such auction-based award mechanisms are namely Competitive Tendering.

[11] There are two other formats which are used for other purposes: Contest and Standard Open Ascending Price Auction. Contest, for example, is used to award technical studies, scientific or art works, while Standard Auction is used for selling public assets.

However, they cannot be used for construction and engineering services.[12], [13], [14]

Whenever an administration authority relies on one of those procurement formats to select a supplier, he must specify the maximum unit price (i.e., reserve price) that is willing to pay to acquire the procured goods and services. This reserve price is determined through a market survey conducted by the agency or authority responsible for the purchase.[15]

■ **Procurement Law in Brazil: Benefits and Drawbacks.** The literature on public procurement in Brazil, summarized by Fiuza (2007), highlights the following benefits of such legislation for the public administration: (i) greater transparency in government procurement, and (ii) best selection of the company to supply goods and services. Such benefits come from the competition between suppliers through a competitive bidding process. In particular, as the auction literature, summarized by Krishna (2002) and Klemperer (2004), has pointed out, auction-based mechanism (competitive bidding), used in most Brazilian procurement transactions, is an efficient mechanism to acquire standardized goods and services. Such mechanism awards the provision of goods and services to the most efficient supplier (the one with the lowest cost), and the buyer pays the lowest price for them.

On the other hand, mandatory competitive bidding (with the exceptions noted above) and rules-based procurement are accountable for a high level of transaction costs in the Brazilian government. For instance, as pointed by Fiuza (2007), excessive red tape in procurement transactions

[12]In some cases, competitive bidding is waived or ineligible. Competitive bidding is waived for products, services and works of extremely low value. Ineligibility applies when competition is not possible, because there is only one supplier, or when the goods can be provided with exclusivity a single company (or representative office).

[13]The Brazilian public administrations may use other selection criteria than auction-based mechanism (i.e., the government selects among the potential providers the one with the lowest bidding price) to select suppliers. For instance, they can base their selection decision on (i) best technique, or on (ii) best technique and price. When the buyer uses the best technique criterion, one supplier with best quality (the precision, safety and durability) wins the competition. In this criterion, the lowest price bidder is not overlooked, but the focus is quality. When the buyer uses the best technique and price criterion, the company with the best quality that have the lowest bidding price wins the competition. It is important to highlight in the Open Hybrid and Electronic Competitive Bidding, the lowest bidding price is the only criterion for selection of suppliers.

[14]Fiuza (2007) documents that when the selection criterion is auction-based mechanism, contracts are awarded through fixed-price contracts. Despite the benefits of fixed-price contracts and the fact that the supplier selection is based on the lowest price, the theoretical and empirical literature warns that the fixed-price contracts may not have the desired properties for the provision of heterogeneous, customized and non-standard goods. Laffont and Tirole (1993), for instance, show that when high quality inputs/activities have high production costs, then fixed-price contracts may lead to the provision of inputs / activities with lower quality. Rosenberg (1994) and Cabral et al. (2006) argue that, when suppliers are unable to diversify risk or are risk averse, fixed-price contracts can lead to selection of less risky technologies, which are not socially optimal. Bajari and Tadelis (2001) show that fixed-price contracts have high renegotiation cost when the non-contractible contingencies are not rare.

[15]In the Brazilian legislation,the reserve price is named "estimated price", although no law completely rules out awarding a contract when the lowest bid exceeds that ceiling.

have ended up forcing the public entities to maintain excessively high inventories of goods.

As a means to warrant the benefits of competitive bidding and at the same time to bring down transactions costs, the Brazilian government created the Brazilian System of Price Registration (PR). In the section below we will discuss in details this system works.

2.2 Pooled Procurement: The Price Registration System

■ **Brief Description.** The Brazilian System of Price Registration (PR) is a pooled procurement system in which several public agencies and entities gather and organize a joint competitive bidding to acquire/purchase goods, and suppliers offer goods and services at uniform prices and terms for all members of the PR. The public entities may contract the winning supplier to provide goods and services and order shipments of various sizes at their own convenience and without a predetermined frequency within a period of 12 months.[16] As in the standard individual procurement system, the administration authority must specify the reserve price, that is, its willingness to pay for the goods/services. The reserve price is also determined through a wide market survey.

The procurement transactions in the Price Registration system must rely on an Open Competitive Bidding, Open Hybrid or Electronic Competitive Bidding. Lowest price is the only award criterion allowed in PR.

According to the Brazilian law, the Price Registration system should be employed when a set of off-the-shelf goods or services are to acquired by more than one agency, entity, or government programs along a year; and when, by the nature of the goods, it is not possible to stipulate precisely the demand for them.[17]

■ **Institutions and Assignments.** There are basically two types of institutions in the Brazilian System of Price Registration(PR): buyers (public entities) and suppliers.

The buyers in a Price Registration pool are classified as managing agency, participating agency, or free-rider. A managing agency is the public entity responsible for the procurement procedures in the PR (e.g., invitation of suppliers for competitive bidding, market research, specification of the demanded goods and quantities, definition of the reserve price, and running the auction), and also for managing all information in the procurement transaction. A participating agency

[16]The Brazilian System of Price Registration is regulated by Decree 3.931/01 and 4.342/02.

[17]The existence of prices recorded in a certain price registration system does not require the members to sign contracts with the supplies of the goods and services registered in the system.

is a public entity that participates in the purchase of goods and helps the manager to organize the procurement procedures. A free-rider, in contrast, does not participate in the procurement process, but he can apply for the acquisition of goods and services at prices and terms convened between the original pool and the awarded supplier.

Suppliers are all companies who apply for the contracts of supply of goods and services to be awarded through a PR - pooled procurement. Any firm that meets the requirements set by the managing agency may apply to be admitted as a new signatory of the PR minutes, the document that certifies the convened price.[18]

3 Demand Aggregation and Credit Risk Effect of Pooled Procurement in the Price Registration System

The Price Registration System (PR) has introduced several benefits for the Brazilian government, by providing more flexibility to the public authorities to purchase goods and contract services. By letting public entities purchase at prices tendered in advance goods and services as they become needed, PR allows for a better management and control of inventories, decreases the number and frequency of competitive tenderings, and consequently reduce costs of compliance with procurement procedures.[19] It is certaintly interesting to search for empirical evidence of such benefits. However, information about public inventories and procurement procedure (administrative costs) are not publicly available.

In this paper we analyze empirically another change introduced by the Brazilian Price Registration System (PR): enabling different public agencies and entities to purchase goods or contract services together through procurement pools. Such study is possible in Brazil since there is a data base, called ComprasNet Data Warehouse, in which all public purchases of standardized goods (pharmaceuticals and medical supplies) performed by public entities through standard individual procurements or pooled procurements are recorded. It allows us to to perform a rigorous econometric analysis.[20]

[18]The winner supplier can opt-out provision for the free-rider.

[19]Singer, Konstantinidis, Roubik and Beffernan (2009) show the centralization of procurement transactions in Chile decreased the number and frequency of tenders, lowering the total expenses with procurement procedures in 0.28%-0.38%.

[20]Secion 5 presents the data set and explain the reason why such data set is appropriate to analyze the benefits and cost of pooled procurements within the Price Registration System.

The theoretical literature on public and private procurement has already analyzed pooled procurements or similar arrangements. In particular, these studies demonstrate that such arrangements of demand aggregation arrangements provide benefits to buyers, but also have drawbacks.

Among the benefits, it is worth noting the aggregation demand effect, which increases volume of purchases of institutions who wish to acquire the same goods or services. Dimitri, Dini and Piga (2006) argues that this effect increases the bargaining power of buyers, allowing them to obtain discounts for bulk buying, and to negotiate better contracts. Additionally, Barbosa (2011) shows that such demand aggregation allows the supplier to achieve economies of scale and scope in production and/or logistics, which may be transferred to buyers through low prices. Based on these theoretical arguments, we can conclude that a benefit of pooled procurement is to lower prices paid for goods and services. This testable hypothesis is formally presented below:

Hypothesis 1 *The price paid by an agency or public entity for the provision of a certain good or service is lower when the purchase is made through the pooled procurement (price registration) than through standard individual procurement.*

However, some studies argue that pooled procurement may increase the price paid for some members of the pool. Albano and Sparro (2008), in analyzing the equilibrium price in the framework agreement game, show that when suppliers commit to provide goods and services at a unique price for horizontally heterogeneous buyers taking part in a procurement pool, then the equilibrium price will reflect the average heterogeneity of buyers. So, buyers close to the supplier will subsidize the buyers which are far away.

Building on Albano and Sparro, we can argue that in a environment where buyers have different risks of delay payment to suppliers, pooled procurement may raise the price of goods and services to buyers with good reputation. It happens because when a reputable buyer is joined by a buyer with a bad reputation in a pooled procurement from the beginning, the good buyer will pay a price that reflects both his own risks of payment delay and default and the ones of the bad buyer.[21] Based on this theoretical argument, we can conclude that the price paid by an agency or public entity will be greater if it joins a pooled procurement with buyers who have worse reputation/greater risks of default. This effect is named credit risk effect.

This second hypothesis is formally presented below:

[21] A buyer who makes late payment of a certain good or service can be considered worse buyer (or has higher credit risk) that a buyer who makes the payment according to the contract rules.

Hypothesis 2 *The price paid by an agency or public entity for the provision of a certain good or service increases (decreases) when it associates, through a pooled procurement, to another buyer with a higher (lower) risk of default.*

4 Econometric Model

Following the literature on empirical auctions and procurement (i.e., Porter and Zona (1993), Jofre-Bonet and Pesendorfer (2000), Gupta (2001 and 2002); Gomez-Lobo and Szymanski (2001), and Iimi (2006)), this paper estimates the following price equation in the competitive bidding for provision of goods and services:

$$\ln p_{ibt} = \sum_{\forall b} \Theta_b + \sum_{\forall t} \alpha_t + X'_{it}\beta + g(N_{ibt}, \gamma) + \delta DumRP_{it} + \theta DPlusRisk_{bt} + \lambda DLessRisk_{bt} + u_{it}, \quad (1)$$

where p_{ibt} is the unit price paid for the provision of a certain good and services i by a buyer b (federal government, states and municipalities) in period t. Parameters Θ_b and α_t are, respectively, dummy variables for each buyer and year. X'_{it} is a vector of observable variables which are product-specific. Such variables are related to production or logistic/transportation cost of each product i in each procurement transaction, which affects the suppliers' bids in the procurement auctions. For instance, these variable may be total amount of purchase of goods and services, distance between buyer and supplier, and number of buyers in the pooled procurement.

The function $g(N_{ibt}, \gamma)$ captures the competition effect on the price paid, and it is expected that this relationship is negative: more competition leads to lower price paid. Such effect measures the benefit of the adoption of auctions to acquire goods and services for public entities in Brazil, where N_{ibt} corresponds to the number of suppliers competing for provision of the good i to the buyer b in the period t. As Rezende (2008) shows, in a selection mechanism such auction, the relationship between price paid and the number of competing suppliers is never linear. Iimi (2006) shows that quadratic and logarithm function capture quite well such competition effect on government price paid.

$DumRP_{it}$ is a dummy variable which is equal to one if the good/service is acquired by pooled procurement (price registration), and zero otherwise. According to Hypothesis 1, it is expected that δ is negative, since the price paid by an agency or public entity must be lower when the purchase is made through a pooled procurement than through standard individual procurement.

The dummy variable $DPlusRisk_{bt}$ is equal to 1 if the buyer has a lower credit risk (i.e., higher probability of making late payment or no payment) than other participants in the pooled procurement, and zero otherwise. Similarly, the dummy variable $DLessRisk_{bt}$ is equal to 1 if the buyer has higher credit risk than the other members of the pool, an zero otherwise. According to Hypothesis 2, θ e λ should have, respectively, positive and negative value, since the price paid by a buyer has to increase (decrease) when it associates, through a pooled procurement, to another buyer with a higher (lower) risk of default.

Variable u_{it} is a stochastic residual. In particular, this variable may stand for a random shock which affects price paid for goods and services. Such variable may also reflect some information about a particular good/service which is not observable buy a econometrician, and probably correlated with the procurement procedure (pooled procurement or standard procurement) chosen by a certain buyer. For instance, less expensive goods can be more often purchased through pooled procurement than more expensive ones. According to Wooldridge (2002), such correlation may bias the estimation of the parameters of interest.

For the reasons above, we assume that the term u_{it} has the following structure:

$$u_{it} = \upsilon_i + \varepsilon_{it}, \tag{2}$$

where υ_i is a fixed-effect of the good/service i, and ε_{it} is a random variable which is not correlated to other regressors in equation 1.

Equation 2 assumes that a possible correlation between the procurement procedure (pooled or not) and unobservable good/service characteristics is time invariant. Such hypothesis allows us to estimate unbiased coefficients of interest using the fixed-effects estimators. This is the estimation method that we adopt in this paper.

As we have discussed before, in any competitive tendering for goods and services procured there is a reserve price. As discussed in Section 2, this reserve price is obtained through a market survey conducted by the managing agency with the assistance of the participating agencies (in a pooled procurement), or by the buyer in the standard individual procurement.

The auction literature (Krishna (2002)) emphasizes the role of the reserve price in lowering prices paid in auctions for acquisition of goods. In particular, these studies show that associated with the choice of the price of the reservation there is a trade-off between increasing competition

between the most efficient suppliers, and the role of the less efficient suppliers in reducing the informational rent of the most efficient ones. A good reserve price is the one which excludes the less efficient competitors (increasing competition among the most efficient suppliers), thereby reducing the price paid by the buyers. An incorrect reserve price may increase the price paid.

In order to correct the estimates for the effect of the reserve price on bidding behavior, it is worthwhile to compare the difference between price paid and reserve price in different procurement regimes (pooled or standard procurement), instead of merely making a comparison between the level of the prices paid in different procurement regimes.

Hence, we estimate the following alternative price equation specification to test Hypothesis 1 and 2:

$$\ln \frac{p_{ibt}}{p^r_{ibt}} = \sum_{\forall b} \Theta_b + \sum_{\forall t} \alpha_t + X'_{it}\beta + g(N_{it}, \gamma) + \delta DumRP_{it} + \theta DPlusRisk_{bt} + \lambda DLessRisk_{bt} + \upsilon_i + \varepsilon_{it}, \tag{3}$$

where $\ln \frac{p_{ibt}}{p^r_{ibt}}$ is the gain obtained by using competitive bidding (pooled or standard procurement) with respect to other procurement procedures, for instance, buying in retail market.[22] Note that, in the equation above, u_{it} was replaced by equation 2.

5 Database

To perform the empirical analysis of the benefits and costs of pooled procurements, we use a data set of the Brazilian public procurement transactions conducted between 2004 and 2009. Such data is available on the ComprasNet's Data Warehouse, and contains information on all purchases made by the federal government, either through pooled procurement (price registration) or through a standard individual procurement. This data set also includes information on all purchases made by state and local governments through pooled procurement, in which the federal government participates, either as a managing agency or as a mere participating agency

For the empirical study, the analysis was limited to the purchases of pharmaceuticals and medical supplies. For such products, all products are described, standardized and codified following to the Brazilian Catalog of Materials and Services classification. Such standardization allows us to

[22]Reserve price is determined by a market survey, and reflects how much the government would paid for the good and service in the retail market. For a great number of drugs the Federal government sponsors a price databank that may be consulted and/or fed by any State or Municipality, and in 2006 a subset of the drugs were included in a list with mandatory rebates to be applied by suppliers to any public entity.

make a rigorous comparison between price paid for each product in different procurement regimes: pooled or standard individual procurement.[23]

In addition, to make a fair comparison between pooled and individual procurement, we considered only the public purchases made on the following procurement formats: Open Competitive Bidding, Open Hybrid and Electronic Competitive Bidding. We made such restriction because, according to the Brazilian legislation, pooled procurement can only be performed in the format above, whereas individual procurement can be made using other different schemes.

The database contains information on the purchase of 8,511 different items-products, comprising five broad categories of health products.[24] Besides the information on the price paid, description and codification of each product purchased by the government, the database also contains information on the year of purchase, the reserve price in each procurement auction, the initially estimated demand for each item by each buyer, the quantity actually purchased, the identification of each supplier taking part in the auction (taxpayer number, location, size category, legal status, etc.) and their total quantities offered,[25] buyer identification, and the number of suppliers competing for provision of each product. Note that when a purchase is performed through pooled procurement, both managing and participating agencies quote their estimated demand, and the actual purchases are recorded for each and every one of them. Information distinguishing the status of the buyer (managing, participating or free rider) had been once made public, but it was removed from DW because it was not reliable, and as of the closure of this version the variable had not been introduced.

This database, besides being interesting by itself as a source of such an amount of available information, has another peculiarity which makes it singular for testing of hypotheses described in the previous section: There is information on products that were purchased at the same time by the same buyers in the two different regimes: pooled or standard individual procurement. This

[23]In Brazil, the standardization and codification of prescription drugs and hospital equipments was performed as part of the strategy of the Federal Ministry of Health aiming to create a Price Databank for pharmaceuticals and medical supplies. Comparison of prices paid across public entities only became possible after the standardization of such attributes as product names, active ingredient strength and dosages.

[24]The products analyzed are classified into classes 6501 (drugs and medicines), 6510 (materials for surgical dressings), 6515 (surgical and medical instruments, equipments, and supplies), 6530 (hospital furniture, equipments, utensils and supplies), 6532 (hospital and surgical clothing and related items) and 6545 (medical tools and sets) of the Brazilian Catalog of Materials and Services .

[25]In the PR regime, a supplier may offer less than the quantity demanded by the pool. In this case, if he wins, the pool invites the second-price bidder to match the first price and to supply the remaining quantity. In the standard procurement procedure, suppliers are only qualified if they pledge to supply the whole amount estimated in the bidding document.

allows us to correct for any endogeneity problem derived from correlation between the standard procurement practices used by a certain buyer to buy a certain product, and the procurement regime.

Despite the advantages described above, this database has problems. Among them, a great number of measurement errors in the unit prices paid by public agencies.[26] In particular, we observe that in many of the public purchases the unit price paid by an agency or public body is higher than its reserve price. Certainly, this is an error in the observations, since, according to Brazilian legislation, the reserve price is the maximum unit value that the public administration is willing to pay.

Table 1 presents some statistics that illustrate the problem above. The first row of the table, for instance, shows that the ratio price paid - reserve price is greater than 1 in 16.5% of sample. It can be noticed also that this problem is more severe on purchases through standard individual procurement than in pooled procurement. In particular, it is observed that the ratio price paid - reserve price is higher than 1 in 11% of the purchases made through pooled procurment, whereas it is more than 1 in 45% of purchases made through standard procurement.

To avoid any bias in the econometric analysis caused by the incorrect insertion of prices paid by the government, we eliminated from the original database all those observations in which the price paid is higher than the reserve price.[27]

Table 2 and 3 provide some descriptive statistics of the sample restricted to observations where the price paid is lower than the reserve price. According to Table 2, this sub-sample contains 95,403 observations, spanning the period from 2004 to 2009. Along this period, 5,248 different products were purchased in each of the different years.

Besides the descriptive statistics of the price paid, reserve price and the ratio price paid - reserve price, this table also describes other variables that affect price. For example, note that 98% of purchases were made using Open Hybrid and Electronic Competitive Bidding. Other variables such as the initial demand (the amount of good that a byer is willing to buy in a procurement)

[26]The main reason for the poor quality of data is the lack of suitably trained civil servants to enter the correct information on the purchases made by the Brazilian public sector in ComprasNet Data Warehouse. The World Bank (2004), a report on the procurement practices in the Brazilian government, documents evidence showing that civil servants in public entities are not well qualified to perform the procurement tasks. Another problem is that they are rarely liable before the Ministry of Budget for typing errors – in other words, data correction is not enforceable.

[27]This exclusion of some observations may lead to bias in the estimates. For this reason, other estimations were performed using the original database of ComprasNet, without excluding any observations. The results are quite similar to those obtained with exclusion of those observations.

and the final purchase (quantity actually ordered by a public entity) can also be found in this table. In the presence of economies of scale and scope in logistics and in the production process, it is expected that the higher the initial demand or final purchase levels, the lower the price paid by the government.

In addition to these variables, information on number of suppliers competing to provide a particular product (competitors), and the number of public bodies participating in a pooled procurement (units/agencies in the pooled procurement) are also available in the database.

Based on information about the supplier´s town location and the buyer's location, we calculated the geodesic distance between buyer and supplier in each procurement transaction (buyer-supplier distance). This variable is a proxy for transportation costs. Certainly the price paid by the government is affected by this variable. Looking at the dummy variables, Federal-Buyer, State-Buyer, and City-Buyer, one can see that most of the purchases was made by the federal government (93%). The remaining is distributed among state government purchases (approx. 7%) and local (less than 1%).

Table 3 presents some descriptive statistics of purchases made through pooled procurement (price registration). First note that 93% of purchases were made through pooled procurement. Moreover, almost all of the purchases made through pooled procurement had the federal government as the managing agency. It was also noted that the demand of the participating agencies in the Pooled Procurement is relatively high, and corresponds to 16% of the pool's total demand. This evidence shows that the total demand for products in procurement transactions is higher when various spheres of government join a pool than when each one buys independently. To conclude, we observe that in about 50% of the purchases made through pooled procurement, there is a participant who is not the managing agency. In particular, in about 40% of the observations, the participant is a federal agency, and in 10% it is a state agency.

Table 4 tests for differences in unconditional means of characteristic of the pooled versus standard individual procurement. Tests show that the unconditional mean of price paid, the reserve price and the total demand are statistically identical in both procurement schemes: pooled and standard individual procurement. On the other hand, tests show that Open Hybrid and Electronic Competitive Bidding are award mechanisms more frequently used in pooled procurement than in individual procurement.[28] Moreover, there is evidence that the total demand and purchase of

[28]Such a difference would be even greater if we had included in the sample the other procurement formats unauthorized in pooled procurement.

products are, on average, higher in pooled than in individual procurement. Note also that the numbers of firms that compete to supply goods and services and the distance between the supplier and buyer are higher on purchases through pooled than individual procurement.

It is worth highlighting that such evidence is a quite crude statistical analysis of unconditional means, and it only displays some characteristics of the database. Observable differences in purchases made may explain the potential difference in price paid by the government and the ratio between price paid and the reserve price in the different procurement schemes (pooled and individual procurement). To control for observable and unobservable characteristics, we will perform an econometric analysis.

6 Estimation

In order to test Hypotheses 1 and 2 described in Section 3, we estimate equations 1 and 3. In particular, Tables 5 to 8 present the estimates of equation 1 using different specifications. The results of estimating equation 3 are shown in Tables 9 to 12.

■ **Determinants of Price Paid.** Table 5 presents several estimates of equation 1. The goal is to identify the determinants of unit price paid for goods purchased by public agencies. First, we observe that in all regressions the coefficient associated with total purchase is significantly negative. This means that the greater the quantity purchased by public agencies in each procurement transaction, the lower the unit price paid.

Among the different specification in Table 5, the results indicates that the specification at column (6) better describes the determinants of unit price paid by the government. The reasons for this are the following. First, looking at R-squared, we observe that it reaches the highest value in the specification at column (6). Secondly, we can observe from columns (2) to (4) that both the distance and the number of suppliers (competitors) seem to have a nonlinear relationship with unit price paid. To verify it, note that when we include the square of the distance within the regressors (and the square of the number of suppliers (competitors)), the estimated coefficient associated with the linear distance (and the linear effect of the number of suppliers (competitors)) modifies and loses significance. Thirdly, we can observe that the regression at column (6), where distance is in natural logarithm, is the only specification in which the parameter associated to the non-linearity of distance is statistically significant.

The results of column (6) suggest that the greater the number of competitors, the lower the price paid by the government. The logarithmic specification of the effect of the number of suppliers (competitors) on the price paid suggests that a reduction in the price paid by the government from an increase in number of competitors is greater when there are fewer competitors than when there are many competitors. This result is consistent with the estimates of Iimi (2006), and with Rezende's (2008) theoretical implications.

Additionally, the results of column (6) show that the greater the distance between the buyer and supplier, the higher the price paid by the government. This result is consistent with the theories on transportation costs, and suggests the existence of some kind of horizontal heterogeneity within the products purchased by the government.[29] The logarithmic specification suggests that the increase in the price paid by the government due a increasing in the distance between the buyer and supplier is greater when the supplier is closest to the buyer when the supplier is relatively far from the buyer.

Among the results on the procurement format, it is interesting to see that the coefficient associated with the dummy variable Open Hybrid and Electronic Competitive Bidding is positive and statistically different from zero. This result seems surprising since it is a consensus within the Brazilian government agencies and public entities that public entities can buy better (lower price paid) when relying on Open Hybrid and Electronic Competitive Bidding.

Usually it is argued that the advantage of Open Hybrid and Electronic Competitive Bidding vis-à-vis other procurement formats is its superior ability in attracting a larger number of competitors-suppliers to a competitive bidding. It increases competition, thereby reducing the price paid by the government. Since in all regressions that we are controlling for the number of suppliers (competitors), it is likely that this benefit of using Open Hybrid and Electronic Competitive Bidding has been captured by that variable. However, it remains to explain why the coefficient associated to that dummy variable is positive and statistically significant. The above argument only explains why it could be non significant.

Among the results on the procurement regimes, it is emphasized that in all regressions in Table 5 that the coefficient associated with the dummy variable Pooled Procurement (Price Registration) is negative and statistically different from zero. This result confirms Hypothesis 1. Thus, we can conclude that the price paid by an agency or public entity for the provision of a certain good or

[29] Competition for horizontally heterogeneous products is analyzed in the Hotelling model. For details, see Tirole (1988).

service is lower when the purchase is made through pooled procurement than standard individual procurement.

A natural criticism that one could make to the results above is that perhaps there is some kind of endogeneity that could explain this result. For instance, one may argue that the cheaper products are purchased through pooled procurement, while the most expensive products are purchased through individual procurement. Our estimation corrects for such bias since in all estimates that we have performed, we use a dummy variable for each product (we used fixed-effects estimation).

A similar endogeneity problem could also appear in the choice of procurement format. For instance, one may argue that the cheaper products are purchased through Open Competitive Bidding, while the most expensive products are purchased through Open Hybrid and Electronic Competitive Bidding. However, the fixed-effects estimation also corrects for this kind of endogeneity.

Table 6 presents other estimates of equation 1. These estimates aim at measuring statistically the effect of other variables on the price paid by the government, and to correct for other endogeneity problems. For this, let us take the specification at column (6) in Table 5 as the baseline estimation. The results of this estimation are presented again at column (1) in Table 6. At column (2) we replace the quantity purchased with the initial demand. The estimates show that the coefficient associated with dummy pooled procurement remains negative and statistically significant, and they present a slightly marginal change.

Another criticism that one could make to our estimations is that there may exist endogeneity problem due a possible correlation between the procurement schemes (pooled or individual procurement) and the buyer. For instance, one may argue that the best buyers (good payers) use pooled procurement to purchase goods, while the worst customers (bad payers) buy goods individually. The results in column (3) in Table 6 correct for this kind of problem, since in these estimations we have included a dummy variable for each buyer. The results at column (3) show that the coefficient associated with the dummy variable pooled procurement remains negative and statistically significant, having just a marginal change when it was introduced a dummy variable for each buyer.[30]

[30]We consider the buyer as Federal Government in the case the some federal public entity makes purchase, as State X (or as City X) in the case that some state public entity (or city public entity) make a purchase. This approach assumes the credit risk is equal for all entities of the same sphere of the government, such that the only factor that makes them different is the distance between the city (where is the public entity) and the supplier. Such heterogeneity is already taken into account in the estimations since the distance is an explanatory variable in

The estimates in Table 7 empirically investigate Hypothesis 2 and test whether the price paid by an agency or public entity for the provision of a certain good or service increases (decreases) when it associates to another buyer with higher (lower) risk of default in a pooled procurement.

Column (1) shows that when a dummy for a non managing participant of a pooled procurement is included in the regression, then there is an increase in the unit price paid by the pool.[31] This provides evidence that the presence of another buyer in the registration price does not necessarily reduce the price paid. Splitting this dummy variable for non managing participant in non managing participant Federal-Buyer, State-Buyer, and City-Buyer, we may explain the results at Column (1). Column (2) shows that when we include a federal or state non managing participant in the pool, there is an increase in unit price paid. In particular, the results show that the presence of a state non managing participant in a pooled procurement increases more than the price paid than the presence of a federal non managing participant. This result provides some empirical evidence supporting Hypothesis 2, since it is quite natural to assume that credit risk of a state government is higher than federal government's credit risk in Brazil.

In addition to that, the results at column (2) show that when we include a dummy variable for a city non managing participant, then the unit price paid is not affected. This result may sound strange, since it is expected that in Brazil the city has a higher default risk that the federal government. However, there is only one city in the sample which is a non managing participant: the city of Sao Paulo. Given that the Sao Paulo's current income tax is very high, it is natural to believe that its ability to pay suppliers is similar to the ability of the federal government.[32]

Columns (3) and (4) in Table 7 consider only the procurement transactions where the federal government was managing participant. According to these results, we observe again that when it includes a participating state to pooled procurement, then there is an increase in unit price paid. This result again provides evidence that Hypothesis 2 is correct. So, it seems that the price paid by an agency or public entity for the provision of a certain good or service increases when it associates, through pooled procurement, to another buyer with a higher risk of default.

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all regressions.

[31] Note that in standard procurements there is no other participant than the managing participant. However, it may exist other participants (non managing participant and free-rider) in pooled procurements. As it turns out, the dummy for a non managing participant will be equal to one only in pooled procurements with more than two public units/agencies.

[32] According to the Minister of Finance in Brazil, in 2000 the city of Sao Paulo had the ratio income tax/current expenditures of the city of Sao Paulo is less than 40%. Such ration indicates that the city has higher ability than the average of Brazilian states and cities.

The estimates of Table 8 test the robustness of these results concerning Hypothesis 1. To this end, we replace the dummy variable pooled procurement with the initial demand of a non managing participant and the number of units/agencies in pooled procurement. The results at column (1) and (2) show that the initial demand of a non managing participant affects the price paid in a quadratic way. This estimation provides positive coefficient for the quadratic term, and negative for the linear term of that variable. This parabolic shape suggests that small demand of non managing participant reduces the price paid, whereas large demand increases the price paid.

One possible explanation for this results bases on the hypothesis that the greater quantity a firm buys, the greater difficulty the firm will face to pay the supplier for the products (controlling for all its other characteristics). Thus, when a non managing participant demands a few units of goods, the risk of default is relatively small. So, the only effect that takes place is the effect of aggregate demand reducing unit price. However, when non managing participant demands large quantity, the risk of default becomes relatively large. Thus, the effect of credit risk will dominate the effect demand aggregation in pooled procurement on unit price, leading to an increase in the price paid.

The results of column (3) and (4) suggest that the number of units/agencies in pooled procurement also affects the price paid in a quadratic way. Different from the result above, the estimate of the quadratic term is negative, whereas it is positive for the linear term of such variable. This parabolic shape suggests that when there are multiple buyers in the pool, price paid decreases, whereas when there are few buyers in a record price, the paid price increases.

One possible interpretation for this result can also be based on the argument that the greater quantity a firm buys, the greater difficulty the firm will face to pay the supplier for the products. Consistently with this, when there are multiple buyers in the pooled procurement, the supplier reduces the risk premium implicit from buyer's default risk, since the suppliers will be diversifying risk by selling for several buyers. Thus, the credit risk effect on price paid is small, then the aggregate demand effect in pooled procurement dominates the risk effect. On the other hand, when there are few buyers in the pool, the supplier will not diversity the credit risk. Therefore, it increases the risk premium in the price paid: a higher risk premium will be included in the price paid, so it makes that risk credit effect dominates the aggregate demand effect (which is small when there are few entities buying).

■ **Determinants of The Gain Obtained from Competitive Bidding.** Tables 9-12 present

the estimates of the determinants of the gains from using competitive bidding vis-à-vis buying directly from the retail market. They correspond to the estimates of equation 3 in Section 4.

The estimates reported in Tables 9-12 for the gain from using competitive bidding are similar to the ones obtained for the price paid in subsection above. Therefore, empirical evidence with respect the gains from adopting competitive bidding also supports Hypotheses 1 and 2.

However, we can also observe that the absolute value of the coefficient associated with the dummy variable pooled procurement in Tables 9-12 is higher than the ones in Tables 5-8. Such evidence suggests that the impact of pooled procurement are higher on the gains from competitive bidding than on the level of the unit price paid.

Although these results suggest that the gains from competitive bidding are higher in pooled procurement than in individual procurement, we should be more careful interpreting this result, since it may happen because the reserve price is larger higher in pooled procurement than in individual one. The next section empirically investigates such potential relationship.

■ **Determinants of Reserve Price.** Tables 13-16 present the estimates of the determinants of unit reserve price for each product purchased by agencies and public entities. Each column corresponds to a different specifications of reserve price equation.[33]

Table 13 presents several different specifications for the determinants of the reserve price. First, we observe that in all estimations the coefficient associated to initial demand is significantly negative. It means that the higher the public agencies' initial demand in each procurement transaction, the lower the unit reserve price. This suggests that agencies and public authorities try to use their bargaining power to reduce unit reserve price when buying large quantities.

Among the estimations presented in Table 13, the results at column (3) seem to better describe the determinants of the unit reserve price. The R-square high at column (3) and low significance of the coefficient associated with the logarithm of distance justify such perception.

The results at column (3) in Table 13 suggest that the distance affects the unit reserve price in a quadratic way. It estimates a negative coefficient for the quadratic term and a positive one for the linear term of the distance. This parabolic shape suggests that when the distance between the buyer and supplier is small, the reserve price increases, whereas the distance is large, reserve price decreases. In particular, note that the inflection point of this parabolic function is 2600 km. As

[33]The estimates exclude the number of competitors in the regressions, since it affects only the price paid by the government through competitive bidding.

the average distance between the buyer and suppliers in the sample is 874 km, and the standard deviation is 804 km, then we can conclude that for most of the observations, the reserve price is increasing in the distance between buyer and supplier.

Regarding the results on the methods and procedures of procurement, the regressions in Table 13 suggest that the coefficient associated with the dummy variable pooled procurement is positive and statistically different from zero. This result confirms the hypothesis raised in the previous section that the gain from competitive bidding is higher in a pooled procurement than in a individual procurement because the reserve price in the former is higher in the former than in the latter.[34]

All regressions were estimated using the fixed-effects estimation method. This procedure corrects for a potential endogeneity problem of the following kind: products with the highest reserve price are purchased through pooled procurement, whereas products with higher reserve price are bought through individual procurement.

Tables 14-15 present other estimates of the determinants of the reserve price. For this, we take the regression at column (3) in Table 13 as the baseline regression model. This estimation is also presented at column (1) in Table 14. In column (2) the initial demand was substituted by quantity purchased. The estimates show that the coefficient associated with the dummy variable pooled procurement remain positive and statistically significant.

Similarly to what we have done to identify the determinants of the price paid by the government, we perform robustness tests to assess whether in fact the reserve price is higher in a pooled procurement than in a individual one. These estimates are shown in Table 16. At columns (1) and (2) in that table we replace the dummy variable pooled procurement for the initial demand of the non managing participant in the pooled procurement. Different from the findings for price paid, the results show there is no evidence saying that the relationship between this variable and reserve price is either linear or quadratic.

At columns (3) and (4) of the same table we replace the dummy variable pooled procurement for the number of units / agencies members of the pooled procurement. The results show that the number of units/agencies in a pooled procurement affects reserve price in a quadratic way. This estimation provides positive coefficient for the quadratic term, and negative one for the linear term of that variable. This parabolic shape suggests that when there are few multiple buyers in

[34]The coefficient associated with the dummy variable Open Hybrid and Electronic Competitive Bidding is positive and statistically different from zero.

a pooled procurement, the reserve price decreases, whereas when there are many multiple buyers, the reserve price increases.

What can explain a higher reserve price in pooled procurement than in an individual one? In particular, what could justify a reserve price increases with the number of participants of a pooled procurement? So, the economic theory on public good provision may help us to explain such evidence.

In section 2 we presented the differences between standard individual procurement and pooled procurement (price registration) in Brazil. One of the differences between these two procurement regimes is that in standard individual procurement, the buyer (who is the managing agency) determine the reserve price from a price market research conducted by himself. As you have noticed, the buyer internalizes all the costs and benefits to estimate correctly the reserve price.

In contrast, in the Brazilian price registration (pooled procurement) all the members of the pool help each other in determining the reserve price of the competitive bidding. Clearly if only one member exerts a effort to correctly determine the reserve price, all other members of the pooled procurement will benefit from such action.

Typically, we are facing a problem of public goods in pooled procurement, where social benefit to correctly determine the reserve price (investing time and resources in price market research) is larger than the private one. Such conditions leaves room for a free-riding behavior among the members of a pooled procurements, which can lead to a determination of the reserve price of poor quality. In our context, poor quality of the reserve price can be interpreted as a high reserve price in pooled procurement vis-à-vis in standard individual one.

7 Limits and Potential Extensions

7.1 Robustness

■ **Robustness Check of Hypothesis 2.** The results of Section 6 show evidence that the price paid by the federal government increases when it associates, through pooled procurement, to state. This result supports Hypothesis 2 that the price paid by an agency or public entity for the provision of a certain good or service increases when it associated, through pooled procurement, to another buyer with a higher risk of default. However, more research is needed to find robust results

supporting it. As robustness check, it would be interesting to see how public finance indicators of liquidity and solvency of federal and state public bodies affect the price paid by the government in procurement transactions. This extension may provide stronger evidence supporting Hypothesis 2.

■ **Procurement Format: Open Hybrid versus Electronic Competitive Bidding.** One of the results in Section 6 is that the coefficient associated with the dummy variable Open Hybrid and Electronic Competitive Bidding is positive and statistically different from zero. As we discussed in that section, we expected that this coefficient was negative, or at least no significant.

One possible explanation is that this paper we consider the Open Hybrid versus Electronic Competitive Bidding as a unique procurement format. We do not take into account they are two types of formats: Hybrid and Electronic, and therefore they may have different effects on the price paid. Therefore, a possible extension that could be make would split this procurement format in two categories and check whether their impacts on price paid are equal or different.

7.2 Extensions

Through the methodology used to identify the demand aggregation and credit risk effect on price paid, which was described Section 4, we could not determine which of the effects dominates and determines ultimately the price paid by public agencies and entities in pooled procurement.

A possible extension would be a development an econometric methodology that allows to identify which of the two effects is dominant in determining the price paid.

8 Conclusion

The theoretical literature points several benefits and costs of the pooled procurement. Among the benefits, some theoretical studies argue pooled procurement aggregates demand. Such aggregation allows buyers to pay lower prices for goods and services. On the other hand, pooled procurement may increase the price paid by its members, because buyers with good reputation can pay higher prices when they join the buyers with bad reputations in a pooled procurement. Using a data base on procurement transactions of pharmaceuticals and medical supplies in Brazil, where several public agencies make purchase through pooled and individual procurement, we test

these hypothesis.

The empirical results support the hypothesis of demand aggregation, showing that the price paid by an agency or public entity for the provision of a certain good is lower in pooled procurements than in individual ones. There is also evidence that the price paid by an agency or public entity for the provision of a certain good increases when it is associates, through a pooled procurement, to another buyer with a higher risk of default. This result supports the hypothesis that the pooled procurement can increase the price paid by certain agents. The estimates reported for the gain from competitive bidding (logarithm of the ratio price paid and reserve price) are similar to those obtained for the price paid.

On the other hand, the estimates suggest that the reserve price is higher in pooled procurement than in individual procurement. One possible explanation is the existence of the free-rider problem in the determination of reserve price in pooled procurements. It happens because the determination of the reserve price in pooled procurement in Brazil is a kind of public good, where the social benefit to determine it correctly (to invest time and resources on price market research) is larger than the private one. Such conditions lead to a equilibrium with low provision (or poor quality) of public good, which can be interpreted as a high reserve price in pooled procurements.

Some potential endogeneity problems (e.g., autocorrelation in the price paid) suggest that some robustness tests still must be performed. It would be also interesting to incorporate risk measures of liquidity and solvency of public institutions (federal, state and municipal) to measure the impact of such indicators on the prices paid for goods.

A possible extension is to develop an econometric methodology that allows to identify which of the two effects, aggregation or credit risk, dominates and determines the price paid by public agencies and entities in pooled procurements.

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Appendix

Table 1: Ratio Price Paid - Reserve Price

The tables below presents some descriptive statistics of the ratio price paid and reserve price in the ComprasNet database. To compute these statistics, we use the entire set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse. The variable **Price Paid** is unit price paid by a public unit or agency for a certain product in a well-defined procurement transactions, either Pooled Procurement (Price Registration) or individual standard procurement. The variable **Reserve Price** is the maximum price that a certain public unity or agency is willing to pay for a well-defined product. In the row **Total** we present the statistics for the entire data set. In the rows **Pooled Procurement** e **Individual Standard Procurement** we can find the statistics for procurement transactions through **Pooled Procurement** and **Individual Standard Procurement**, respectively.

		Percentis of Ratio Price Paid- Reserve Price			Probability of the Ratio Price Paid- Reserve Price greater than 1
	Number of Observations	25%	50%	75%	
Total	121082	0.42	0.73	4898.79	16.5%
Pooled Procurement	99310	0.39	0.69	0.94	11%
Individual Procurement*	21772	0.64	0.99	6069.62	45%

*Individual Procurement in the following formats: Unrestricted Hybrid and Electronic Competitive Bidding, and Unrestricted Competitive Bidding

Table 2: Descriptive Statistics - Procurement Transactions Characteristics

The table below presents descriptive statistics of the observations that we use in the paper, with respect to procurement transactions characteristics in either procurement schemes, Pooled Procurement or Individual Standard Procurement. The variable **Price Paid** is unit price paid by a public unit or agency for a certain product in a well-defined procurement transactions, either Pooled Procurement (Price Registration) or individual standard procurement. The variable **Reserve Price** is the maximum price that a certain public unity or agency is willing to pay for a well-defined product. The dummy variable **Open Hybrid and Electronic Competitive Bidding** assume value equal to 1 if the procurement format used for the purchase of a product is Open Hybrid and Electronic Competitive Bidding, and zero if the format is Open Competitive Bidding. The variable **Initial Demand** is the amount of the product that a public unit or agency is willing to buy of a product in a procurement transaction, before the competitive bidding takes place. The variable **Quantity Purchased** is the amount of the product that a public unit or agency buys from the product after the competitive bidding takes place. Such variable is not available in ComprasNet data set. It is computed dividing the variable **Total Value of the Purchase** by **Unit Price Paid**. The variable **Total Value of the Purchase** is the total expenses to acquired a certain amount of a product by a public unit or agency. The variable **Competitors** is the number of suppliers that compete in a competitive bidding (Open Hybrid and Electronic Competitive Bidding, or Open Competitive Bidding) to provide a certain product to a public unit or agency. The variable **Units / agencies in a Procurement Transaction** is the number public units or agencies in Procurement Transaction that participate in a certain procurement transaction. When it is a individual procurement, such variable is equal to 1. When it is a Pooled Procurement, that variable is greater than 1. The variable **Distance Buyer-Supplier** measures the geodesic distance between a buyer and seller which wins the competitive bidding for a certain product. The dummy variables **Buyer - Federal Agency**, **Buyer - State Agency** and **Buyer - City Agency** are equal to 1 when the buyer is, respectively, a public unit or agency which belongs to the federal, state or city government. Otherwise, such variable is equal zero. On the bottom of the table, we have dummy variable for each year. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

Variable	Number of Observations	Mean	Standard Deviation
Price Paid (unit)	95403	34.16	994.09
Reserve Price (unit)	95403	735811.9	227000000
Ratio Price Paid-Reserve Price	95403	0.60	0.30
Open Hybrid and Electronic Competitive Bidding (dummy)	95403	0.98	0.15
Initial Demand (units)	95403	94165	2084659
Quantity Purchased (units)	95403	92685	2037767
Total Value of the Purchase	95403	38610	790535
Competitors (suppliers)	95403	4.91	3.99
Units/ Agencies in Pooled Procurement	95251	25.37	126.65
Distance Buyer-Supplier	95403	874.29	804.21
Buyer - Federal Agency (dummy)	95403	0.93	0.25
Buyer - State Agency (dummy)	95403	0.07	0.25
Buyer - City Agency (dummy)	95403	0.00	0.01
2004 (dummy)	95403	0.01	0.01
2005 (dummy)	95403	0.22	0.41
2006 (dummy)	95403	0.19	0.40
2007 (dummy)	95403	0.22	0.42
2008 (dummy)	95403	0.00	0.05
2009 (dummy)	95403	0.35	0.48
Number of Products	5248		

Table 3: Descriptive Statistics - Pooled Procurement Characteristics

The table below presents descriptive statistics of the observations that we use in the paper, with respect to purchased made through Pooled Procurement. The dummy variable **Pooled Procurement** is equal to 1 if the procurement transaction for a certain product was made through a Price Registration. The dummy variables **Buyer - Federal Agency**, **Buyer - State Agency** and **Buyer - City Agency** are equal to 1 when the buyer is, respectively, a public unit or agency which belongs to the federal, state or city government. Otherwise, such variable is equal zero. The variable **Initial Demand of a Non Managing Participant** is is the amount of the product that a public agency which a non managing participant in a pooled procurement is willing to buy of a product in a procurement transaction, before the competitive bidding takes place. The dummy variable **Non Managing Participant** is equal to 1 when the buyer is not managing participant of the pooled procurement. Otherwise, that variable is equal to zero. The dummy s, **Non Managing Participant - Federal Agency**, **Non Managing Participant - State Agency** e **Non Managing Participant - City Agency** are equal to 1 when buyer, which is not a managing participant of the pooled procurement, in a procurement transaction belongs to federal, stat, or city government, respectively. Otherwise, these variable are equal to zero. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

Variable	Number of Observations	Mean	Standard Deviation
Pooled Procurement (dummy)	95403	0.93	0.25
Managing Participant - Federal Agency (dummy)	95076	1.00	0.00
Managing Participant - State Agency (dummy)	95076	0.00	0.01
Managing Participant - City Agency (dummy)	95076	0.00	0.00
Initial Demand Non Managing Participant	95293	15616	841236
Non Managing Participant (dummy)	95403	0.50	0.50
Non Managing Participant - Federal Agency (dummy)	95403	0.40	0.00
Non Managing Participant - State Agency (dummy)	95403	0.10	0.30
Non Managing Participant - City Agency (dummy)	95403	0.00	0.05

Table 4: Pooled Procurement and Individual Procurement - Difference between Means

The table below presents the difference between the unconditional mean of the purchases made through pooled procurement and individual procurement. In addition, it displays the results of a test which checks if there is any statistically different between these variables. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	Pooled Procurement	Individual Procurement*	t-statistics	P-value**
Price Paid (unit)	34.18	33.85	0.03	0.98
Reserve Price (unit)	787365	45.95	0.27	0.79
Ratio Price Paid-Reserve Price	0.60	0.70	-26.75	0.00
Open Hybrid and Electronic Competitive Bidding (dummy)	0.98	0.97	3.28	0.00
Initial Demand (units)	98121	37708	2.21	0.03
Quantity Purchased (units)	96537	37708	2.21	0.03
Total Value of the Purchase	37819	49898	-1.17	0.24
Competitors (suppliers)	4.93	4.64	5.59	0.00
Units/ Agencies in the Procurement Transaction	27	1.00	16	0.00
Distance Buyer-Supplier	887.30	688.66	18.91	0.00

*Individual Procurement in the following formats: Unrestricted Hybrid and Electronic Competitive Bidding, and Unrestricted Competitive Bidding

** P-value for two tailed test.

Table 5: Determinants of Unit Price Paid by the Government - Preliminary Regressions

In all columns below the dependent variable is the natural logarithm of the unit price paid by the public unit and agencies for a specific good. The unit price paid by the public unit and agencies is deflated by the official price index (IPCA). The variable quantity purchase is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In regressions (2)-(6) we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)	(5)	(6)
Pooled Procurement (dummy)	-0.162***	-0.145***	-0.149***	-0.0525*	-0.165***	-0.0701**
	(-14.38)	(-7.65)	(-7.92)	(-2.39)	(-8.73)	(-3.20)
Year	-0.0648***					
	(-36.90)					
Open Hybrid and Electronic	0.286***	0.322***	0.408***	0.414***	0.446***	0.455***
Competitive Bidding (dummy)	(14.71)	(16.39)	(20.67)	(19.96)	(22.48)	(21.83)
Quantity Purchased (log)	-0.124***	-0.127***	-0.124***	-0.125***	-0.118***	-0.118***
	(-91.29)	(-91.22)	(-88.83)	(-83.91)	(-87.47)	(-82.18)
Distance	0.0000142***	0.0000186***	0.0000250*		0.0000342***	
	(4.56)	(5.94)	(2.53)		(3.47)	
Distance (square)			-2.09e-09		-5.60e-09	
			(-0.55)		(-1.48)	
Distance (log)				0.00499		0.00561*
				(1.80)		(2.03)
Competitors	-0.0275***	-0.0258***	-0.0862***	-0.0858***		
	(-31.69)	(-29.29)	(-44.06)	(-40.81)		
Competitors (square)			0.00354***	0.00350***		
			(34.55)	(32.30)		
Competitors (log)					-0.199***	-0.203***
					(-47.53)	(-44.39)
Constant	130.9***	1.129***	1.143***	1.021***	1.024***	0.898***
	(37.21)	(28.44)	(28.89)	(21.50)	(25.86)	(18.91)
Observations	95403	95403	95403	80040	95403	80040
Products	5248	5248	5248	4787	5248	4787
$R-square$	0.172	0.174	0.184	0.188	0.186	0.191

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Determinants of Unit Price Paid by the Government - Demand Aggregation Effect

In all columns below the dependent variable is the natural logarithm of the unit price paid by the public unit and agencies for a specific good. The unit price paid by the public unit and agencies is deflated by the official price index (IPCA). The variable quantity purchase and initial demand are in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. In regression (3) we included a dummy variable for each buyer. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)
Pooled Procurement (dummy)	-0.0701**	-0.0779***	-0.0741***
	(-3.20)	(-3.54)	(-3.30)
Open Hybrid and Electronic Competitive Bidding (dummy)	0.455***	0.437***	0.424***
	(21.83)	(20.90)	(19.74)
Quantity Purchased (log)	-0.118***		-0.124***
	(-82.18)		(-79.71)
Initial Demand (log)		-0.114***	
		(-79.13)	
Distance (log)	0.00561*	0.00558*	0.00596*
	(2.03)	(2.02)	(2.03)
Competitors (log)	-0.203***	-0.209***	-0.203***
	(-44.39)	(-45.52)	(-41.75)
Constant	0.898***	0.896***	1.064***
	(18.91)	(18.81)	(6.00)
Observations	80040	80040	73420
Products	4787	4787	4787
$R-square$	0.191	0.186	0.192

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Determinants of Unit Price Paid by the Government - Credit Risk Effect

In all columns below the dependent variable is the natural logarithm of the unit price paid by the public unit and agencies for a specific good. The unit price paid by the public unit and agencies are deflated by the oficial price index (IPCA). The variable quantity purchase is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported.To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)
Pooled Procurement (dummy)	-0.0857***	-0.0941***	-0.0728**	-0.0729**
	(-3.74)	(-4.24)	(-3.22)	(-3.22)
Open Hybrid and Electronic Competitive Bidding (dummy)	0.442***	0.415***	0.432***	0.432***
	(20.94)	(19.62)	(20.59)	(20.58)
Quantity Purchased (log)	-0.119***	-0.123***	-0.122***	-0.122***
	(-81.62)	(-81.83)	(-81.71)	(-81.71)
Distance (log)	0.00384	0.00167	0.00282	0.00285
	(1.38)	(0.60)	(1.01)	(1.03)
Competitors (log)	-0.204***	-0.203***	-0.203***	-0.203***
	(-44.46)	(-44.32)	(-44.22)	(-44.23)
Managing Participant - Federal Agency (dummy)	0.161			
	(0.49)			
Non Managing Participant (dummy)	0.0300***			
	(4.64)			
Non Managing Participant - Federal Agency (dummy)		0.0360***		
		(5.62)		
Non Managing Participant - State Agency (dummy)		0.0945***	0.0955***	0.0948***
		(9.67)	(9.84)	(9.70)
Non Managing Participant - City Agency (dummy)		0.0315		0.0379
		(0.57)		(0.69)
Constant	0.729*	0.996***	0.918***	0.919***
	(2.19)	(20.64)	(15.55)	(15.55)
Observations	79801	80040	79796	79796
Products	4773	4787	4773	4773
$R-square$	0.191	0.192	0.192	0.192

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Demand Aggregation Effect on the Unit Price Paid by the Government - Robustness Tests

In all columns below the dependent variable is the natural logarithm of the unit price paid by the public unit and agencies for a specific good. The unit price paid by the public unit and agencies are deflated by the official price index (IPCA). The variable quantity purchase is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. The variable **Units / agencies in the Pooled Procurement** is is the number public units or agencies in a purchase if it is made through Pooled Procurement. This variable is equal to zero when the purchase is made through individual procurement. The other variable were defined previously. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)
Open Hybrid and Electronic Competitive Bidding (dummy)	0.808***	0.813***	0.452***	0.434***
	(10.80)	(10.86)	(21.69)	(20.76)
Quantity Purchased (log)	-0.101***	-0.103***	-0.123***	-0.126***
	(-48.00)	(-44.91)	(-83.43)	(-83.83)
Distance (log)	0.00864	0.00871	0.00420	0.00384
	(1.92)	(1.93)	(1.52)	(1.39)
Competitors (log)	-0.207***	-0.206***	-0.204***	-0.205***
	(-30.63)	(-30.45)	(-44.58)	(-44.81)
Initial Demand of a Non Managing Participant (log)	-0.0000349	-0.00859*		
	(-0.02)	(-2.14)		
Initial Demand of a Non Managing Participant (log) square		0.000905*		
		(2.36)		
Units / agencies in the Pooled Procurement			0.000218***	0.000773***
			(9.78)	(13.06)
Units / agencies in the Pooled Procurement (square)				-0.000000473***
				(-10.12)
Constant	0.212*	0.235**	0.878***	0.913***
	(2.38)	(2.62)	(19.81)	(20.54)
Observations	34768	34768	80040	80040
Products	3561	3561	4787	4787
$R - square$	0.191	0.191	0.192	0.193

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Determinants of The Gain from Adopting Competitive Bidding - Preliminary Regressions

In all columns below the dependent variable is the natural logarithm of ratio of the unit price paid and reserve price a good purchased. The variable quantity purchase is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In regressions (2)-(6) we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)	(5)	(6)
Pooled Procurement (dummy)	-0.480***	-0.819***	-0.823***	-0.716***	-0.820***	-0.715***
	(-24.73)	(-25.10)	(-25.25)	(-18.64)	(-25.16)	(-18.61)
Year	0.165***					
	(54.46)					
Open Hybrid and Electronic	-0.383***	-0.541***	-0.488***	-0.485***	-0.428***	-0.429***
Competitive Bidding (dummy)	(-11.40)	(-16.02)	(-14.32)	(-13.34)	(-12.50)	(-11.71)
Quantity Purchased (log)	0.0218***	0.0407***	0.0447***	0.0455***	0.0408***	0.0423***
	(9.32)	(17.02)	(18.59)	(17.45)	(17.54)	(16.77)
Distance	0.0000379***	0.0000163**	-0.0000756***		-0.0000683***	
	(7.04)	(3.03)	(-4.44)		(-4.00)	
Distance (square)			3.74e-08***		3.45e-08***	
			(5.74)		(5.28)	
Distance (log)				0.0164***		0.0168***
				(3.38)		(3.46)
Competitors	-0.0408***	-0.0499***	-0.0971***	-0.0968***		
	(-27.15)	(-32.96)	(-28.76)	(-26.28)		
Competitors (square)			0.00280***	0.00294***		
			(15.84)	(15.49)		
Competitors (log)					-0.258***	-0.250***
					(-35.59)	(-31.07)
Constant	-331.4***	-0.579***	-0.536***	-0.518***	-0.614***	-0.595***
	(-54.52)	(-8.49)	(-7.86)	(-6.23)	(-8.98)	(-7.14)
Observations	95403	95403	95403	80040	95403	80040
Products	5248	5248	5248	4787	5248	4787
$R-square$	0.039	0.052	0.055	0.050	0.054	0.049

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Determinants of The Gain from Adopting Competitive Bidding - Demand Aggregation Effect

In all columns below the dependent variable is the natural logarithm of ratio of the unit price paid and reserve price a good purchased. The variables initial demand and quantity purchase are in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. In regression (3) we included a dummy variable for each buyer. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)
Pooled Procurement (dummy)	-0.715***	-0.695***	-0.752***
	(-18.61)	(-18.07)	(-19.16)
Open Hybrid and Electronic Competitive Bidding (dummy)	-0.429***	-0.424***	-0.551***
	(-11.71)	(-11.57)	(-14.65)
Quantity Purchased (log)	0.0423***		0.0259***
	(16.77)		(9.54)
Initial Demand (log)		0.0336***	
		(13.34)	
Distance (log)	0.0168***	0.0165***	0.0247***
	(3.46)	(3.41)	(4.82)
Competitors (log)	-0.250***	-0.236***	-0.260***
	(-31.07)	(-29.35)	(-30.57)
Constant	-0.595***	-0.560***	0.490
	(-7.14)	(-6.71)	(1.58)
Observations	80040	80040	73420
Grupo	4787	4787	4700
$R-square$	0.049	0.048	0.061

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Determinants of The Gain from Adopting Competitive Bidding - Credit Risk Effect

In all columns below the dependent variable is the natural logarithm of ratio of the unit price paid and reserve price a good purchased. The variables initial demand and quantity purchase are in logarithm. The variable quantity purchase is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)
Pooled Procurement (dummy)	-0.829***	-0.889***	-0.695***	-0.696***
	(-20.68)	(-23.06)	(-17.59)	(-17.62)
Open Hybrid and Electronic Competitive Bidding (dummy)	-0.557***	-0.675***	-0.550***	-0.552***
	(-15.09)	(-18.35)	(-15.00)	(-15.06)
Quantity Purchased (log)	0.0322***	0.0121***	0.0223***	0.0221***
	(12.62)	(4.63)	(8.57)	(8.49)
Distance (log)	-0.000261	-0.00602	0.00176	0.00215
	(-0.05)	(-1.24)	(0.36)	(0.44)
Competitors (log)	-0.252***	-0.250***	-0.246***	-0.247***
	(-31.35)	(-31.36)	(-30.66)	(-30.75)
Managing Participant - Federal Agency (dummy)	-0.396			
	(-0.69)			
Non Managing Participant (dummy)	0.271***			
	(23.99)			
Non Managing Participant - Federal Agency (dummy)		0.276***		
		(24.72)		
Non Managing Participant - State Agency (dummy)		0.481***	0.493***	0.485***
		(28.31)	(29.10)	(28.41)
Non Managing Participant - City Agency (dummy)		0.369***		0.416***
		(3.85)		(4.32)
Constant	-0.129	-0.00603	-0.534***	-0.531***
	(-0.22)	(-0.07)	(-5.18)	(-5.15)
Observations	79801	80040	79796	79796
Products	4773	4787	4773	4773
$R-square$	0.056	0.067	0.060	0.060

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Determinants of The Gain from Adopting Competitive Bidding - Robustness Tests

In all columns below the dependent variable is the natural logarithm of ratio of the unit price paid and reserve price a good purchased. The variables initial demand and quantity purchase are in logarithm. The variable quantity purchase is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. The variable **Units / agencies in the Pooled Procurement** is is the number public units or agencies in a purchase if it is made through Pooled Procurement. This variable is equal to zero when the purchase is made through individual procurement. The other variable were defined previously. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)
Open Hybrid and Electronic Competitive Bidding (dummy)	-0.142	-0.137	-0.437***	-0.505***
	(-1.01)	(-0.98)	(-11.98)	(-13.83)
Quantity Purchased (log)	0.0578***	0.0556***	0.0171***	0.00578*
	(14.61)	(12.87)	(6.63)	(2.21)
Distance (log)	0.0479***	0.0480***	0.00819	0.00684
	(5.66)	(5.67)	(1.70)	(1.42)
Competitors (log)	-0.209***	-0.208***	-0.246***	-0.250***
	(-16.45)	(-16.35)	(-30.75)	(-31.29)
Initial Demand of a Non Managing Participant (log)	0.00548	-0.00318		
	(1.68)	(-0.42)		
Initial Demand of a Non Managing Participant (log) Square		0.000916		
		(1.28)		
Units / agencies in the Pooled Procurement			0.00105***	0.00312***
			(26.97)	(30.25)
Units / agencies in the Pooled Procurement(square)				-0.00000177***
				(-21.65)
Constant	-1.863***	-1.840***	-0.990***	-0.862***
	(-11.13)	(-10.93)	(-12.76)	(-11.11)
Observations	34768	34768	80040	80040
Products	3561	3561	4787	4787
$R-square$	0.037	0.037	0.054	0.060

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Determinants of the Reserve Price - Preliminary Regressions

In all columns below the dependent variable is the natural logarithm of reserve price for a specific good. The reserve price is deflated by the official price index (IPCA). The initial demand is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In regressions (2)-(3) we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)
Pooled Procurement (dummy)	0.311***	0.619***	0.608***
	(14.76)	(17.54)	(14.63)
Year	-0.224***		
	(-69.38)		
Open Hybrid and Electronic Competitive Bidding (dummy)	0.677***	0.893***	0.886***
	(18.70)	(24.44)	(22.84)
Initial Demand (log)	-0.126***	-0.141***	-0.143***
	(-58.26)	(-63.47)	(-60.46)
Distance	-0.0000206***	0.000104***	
	(-3.53)	(5.64)	
Distance (square)		-4.00e-08***	
		(-5.66)	
Distance (log)			-0.0107*
			(-2.03)
Constant	451.0***	1.560***	1.426***
	(69.61)	(21.14)	(15.87)
Observations	95403	95403	80040
Products	5248	5248	4787
$R-square$	0.077	0.090	0.087

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Determinants of the Reserve Price - Demand Aggregation Effect

In all columns below the dependent variable is the natural logarithm of the reserve price for a specific good. The reserve price is deflated by the official price index (IPCA). The initial demand and quantity purchase are in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. In regression (3) we included a dummy variable for each buyer. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)
Pooled Procurement (dummy)	0.619***	0.638***	0.640***
	(17.54)	(18.12)	(17.77)
Open Hybrid and Electronic Competitive Bidding (dummy)	0.893***	0.927***	0.983***
	(24.44)	(25.42)	(26.25)
Initial Demand (log)	-0.141***		-0.129***
	(-63.47)		(-53.90)
Quantity Purchased (log)		-0.150***	
		(-67.56)	
Distance	0.000104***	0.000115***	0.000139***
	(5.64)	(6.25)	(7.12)
Distance (square)	-4.00e-08***	-4.47e-08***	-5.72e-08***
	(-5.66)	(-6.34)	(-7.51)
Constant	1.560***	1.573***	0.677*
	(21.14)	(21.38)	(2.04)
Observations	95403	95403	88765
Products	5248	5248	5185
$R-square$	0.090	0.095	0.094

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15: Determinants of the Reserve Price - Credit Risk Effect

In all columns below the dependent variable is the natural logarithm of the unit reserve price for a specific good. The reserve price is deflated by the official price index (IPCA). The variables initial demand is in logarithm. The coefficients are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)
Pooled Procurement (dummy)	0.682***	0.761***	0.560***	0.560***
	(18.51)	(21.45)	(15.37)	(15.38)
Open Hybrid and Electronic Competitive Bidding (dummy)	1.014***	1.094***	0.976***	0.978***
	(27.54)	(29.73)	(26.64)	(26.69)
Initial Demand (log)	-0.130***	-0.115***	-0.124***	-0.124***
	(-57.60)	(-48.94)	(-53.57)	(-53.46)
Distance	0.000141***	0.000154***	0.000125***	0.000125***
	(7.60)	(8.35)	(6.75)	(6.79)
Distance (square)	-4.43e-08***	-4.65e-08***	-3.91e-08***	-3.95e-08***
	(-6.28)	(-6.61)	(-5.54)	(-5.61)
Managing Agency - Federal Agency (dummy)	0.309			
	(0.55)			
Non Managing Participant (dummy)	-0.264***			
	(-23.96)			
Non Managing Participant - Federal Agency (dummy)		-0.261***		
		(-23.86)		
Non Managing Participant - State Agency (dummy)		-0.390***	-0.409***	-0.401***
		(-21.84)	(-23.01)	(-22.41)
Non Managing Participant - City Agency (dummy)		-0.328**		-0.366***
		(-3.23)		(-3.59)
Constant	1.463*	1.167***	1.828***	1.824***
	(2.56)	(15.71)	(19.91)	(19.86)
Observations	95076	95403	95070	95070
Products	5231	5148	5231	5231
$R-square$	0.096	0.101	0.096	0.096

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16: Demand Aggregation Effect on Reserve Price - Robustness Tests

In all columns below the dependent variable is the natural logarithm of the unit reserve price for a specific good. The unit reserve price is deflated by the official price index (IPCA). The variable quantity purchase is in logarithm. The coefficient are estimated by least square for panel data, through fixed-effects estimation. In all regressions we included dummy variables for the year of the procurement transaction. The coefficients associated to year dummy variable are not reported. The variable **Units / agencies in the Pooled Procurement** is is the number public units or agencies in a purchase if it is made through Pooled Procurement. This variable is equal to zero when the purchase is made through individual procurement. The other variable were defined previously. To compute these statistics, we use the set of observations on procurement transactions of pharmaceuticals and medical supplies available in ComprasNet Data Warehouse which the ratio price paid and reserve price is lower than 1.

	(1)	(2)	(3)	(4)
Open Hybrid and Electronic Competitive Bidding (dummy)	0.872***	0.865***	0.894***	0.943***
	(6.11)	(6.07)	(24.49)	(25.77)
Initial Demand (log)	-0.145***	-0.143***	-0.120***	-0.112***
	(-41.96)	(-37.37)	(-52.46)	(-47.51)
Distance	0.000157***	0.000157***	0.000117***	0.000127***
	(5.19)	(5.19)	(6.34)	(6.89)
Distance (square)	-6.48e-08***	-6.48e-08***	-4.10e-08***	-4.44e-08***
	(-6.20)	(-6.21)	(-5.81)	(-6.30)
Initial Demand of a Non Managing Participant (log) Square		-0.00126		
		(-1.72)		
Initial Demand of a Non Managing Participant (log)	-0.00693*	0.00488		
	(-2.10)	(0.64)		
Units / agencies in the Pooled Procurement			-0.000874***	-0.00246***
			(-21.24)	(-22.67)
Units / agencies in the Pooled Procurement(square)				0.00000135***
				(15.79)
Constant	1.627***	1.597***	1.979***	1.888***
	(10.24)	(9.99)	(29.40)	(27.98)
Observations	37661	37661	95403	95403
Products	3638	3638	5248	5248
$R - square$	0.093	0.093	0.091	0.094

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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