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DISCUSSION PAPER

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A New Indicator to Implement Effective Spending Review Policies in the Public Procurement for Standardized Goods

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A new indicator to implement effective spending review policies in the public procurement for standardized goods*

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Abstract

We suggest an alternative indicator that can lead to price reductions in the public procurement market for goods, i.e., the elasticity of prices to quantities purchased. We apply the analysis to the procurement of medical devices by exploiting a survey from the Italian AntiCorruption Authority. The data report for each contract and a series of buyers across the country: a) the quantities, b) the unitary price for the devices, and c) the characteristics of the devices. We find that our measure could provide savings equal to about 17% of the total expenses.

JEL codes: H51; H57; H75; I18

Keywords: Public procurement; Medical devices; Spending review

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1 Introduction

The economics literature has documented substantial variation in the prices of hospital supplies, including variation across hospitals (Grennan and Swanson, 2020). Proposed solutions involved benchmarking approaches, namely inefficient hospitals observing the prices paid by the most efficient ones. This policy would reduce prices and their dispersion by improving the bargaining ability of buyers. Reference prices are another form of regulation that tries to limit the market power of suppliers and their degree of price discrimination. Binding reference prices have been able to decrease public spending, although with heterogeneous effects across public buyers (Bucciol et al., 2020).[1]

In this study, our first line of inquiry shows that reference prices, even when non-binding, imply distortions in the market. Motivated by this finding, as our second contribution, we provide an alternative indicator to reduce prices paid by public buyers. This indicator is based on the elasticity of prices to quantities since quantities in a contract explain a large variation in prices paid.

We apply our analysis to the Italian public procurement market for medical devices. Since 2012, a binding reference price policy has been enacted to reduce spending and the degree of price discrimination of suppliers across different public buyers. This legislation was shortly invalidated, and the reference prices became a non-binding benchmark for the following years. In addition to the change in regulation from binding to non-binding reference prices, Italy provides a good testing ground for a few more reasons: a) there has been a survey on the procurement of medical devices implemented by the Italian Anticorruption Authority where two critical information are reported, namely the unit price of the device and the quantities in the contract, and b) quantities in the contracts are decided in advance with respect to the award of the contract, thus avoiding the problem of simultaneity bias.

In the first part of the paper, we study whether non-binding reference prices lead to inefficiencies. In procurement for goods, in particular, it is often observed that if a buyer buys more, the unitary price is lower (Bandiera et al., 2009; Dubois et al., 2021; Clark et al., 2021). Nonbinding reference prices can affect this relationship in two ways. First, they might favor tacit collusion between firms. Firms know the level at which the reference price is set, and regardless of how many quantities they sell, they offer that price (Knittel and Stango, 2003). Second, buyers use the reference prices as the only information in the negotiation without knowing that, if they buy more, they could obtain a lower price than the reference price.[2]

We estimate a local linear regression and observe a discontinuity in the relationship between prices paid and quantities purchased around the reference price. This suggests

[1] Policies of external reference pricing (across countries) have been able to act as a deterrent to entry in the market for drugs (Maini and Pammolli, 2023).

[2] The problem of bureaucratic competence on procurement outcomes has been studied in Decarolis et al. (2020).

possible distortions introduced by the legislation, which persist even when these prices are non-binding. We also show that this discontinuity seems unequivocally related to the level of the reference prices since it disappears if we consider an alternative measure of reference prices.

In the second part, we propose an alternative procedure to reduce prices, which is based on the elasticity of prices to quantities and might be more effective than other policies aimed at reducing public procurement spending. Our procedure is based on the bargaining ability of the buyers, namely the ability to obtain bulk discounts. This alternative procedure avoids what has been already documented in Bucciol et al. (2020), namely that public buyers with stronger bargaining abilities are worse off when reference prices are introduced. This result might be driven by the way the reference prices were implemented, i.e., by only studying the price distribution.

This paper is also related to the literature on price transparency. Albæk et al. (1997) study the evolution of prices after the Danish competition authority published firm-specific transaction prices for concrete in some regions of Denmark. Similarly, Luco (2019) shows that once price information is disclosed to firms and consumers, this policy causes an increase in firms' margins. Brown (2019) uses the introduction of a state-run website providing information about out-of-pocket prices for some medical procedures in New Hampshire in the US to check whether this event affected spending for those visits whose information is available on the website. Brown (2019) also disentangles the supply from the demand side effects of price transparency. Finally, Grennan and Swanson (2020) document that if a hospital knows the prices paid by peer hospitals for medical devices, it will pay lower prices. Knowing the performance of peer hospitals reduces the asymmetric information between buyer and supplier. Using RDD techniques, we document that fully transparent and non-binding reference prices imply distortions. However, we cannot unequivocally relate these distortions to the presence of focal point pricing, as in Knittel and Stango (2003).

This paper relates to the literature on policies aimed at decreasing hospital costs. Grennan (2013) documents that the effectiveness of these policies depends on i) the extent to which they soften competition and ii) the bargaining ability of hospitals. Grennan and Swanson (2020) attribute the reason for increasing hospital costs and the related price dispersion in the procurement of medical devices to the lack of information. While these articles consider a setting where prices are negotiated between private buyers (hospitals in the US) and suppliers, we apply the analysis to a subset of public hospitals. The first application to the context of public hospitals is by Bucciol et al. (2020). Bucciol et al. (2020) infer that the bureaucratic competence of public hospitals to bargain with suppliers in business-to-government transactions explains a significant part of the price variation. In addition, reference prices could only slightly decrease public expenditure: efficient hospitals pay higher prices when the reference prices are in place, and inefficient hospitals can

instead pay lower prices. Another recent paper investigating the effect of reference pricing policies is Dubois et al. (2021), which analyzes the effect of a hypothetical reference pricing policy in the US. Another policy aimed at decreasing hospital costs is centralized procurement. Baldi and Vannoni (2017) finally shows that centralized procurement policies effectively improve the performance of those buyers more exposed to corruption. We contribute to this literature on policies aimed at decreasing hospital costs by proposing an alternative spending review policy based on the elasticity of prices to quantities. This is important especially in contexts in which the purchases still have some degree of decentralization, such as the one we observe in our analysis. Chiappinelli (2020) shows that in decentralized settings contracting authorities might get lower prices only when they are competent enough. Thus, providing this alternative and "bargaining-based" instrument might help even the less competent authorities when they buy autonomously.

Finally, this paper also contributes to the literature on healthcare public procurement policies implemented during years of fiscal consolidation. Kastanioti et al. (2013) documents the procurement policies implemented since 2010 in Greece to reduce procurement spending. We suggest a different policy especially suitable for decentralized (and thus typically smaller) purchases in countries with high and inefficient procurement spending.

The paper is structured as follows. Section 2 presents the legislative background. Section 3 describes the data. In Section 4, I explain the motivating facts behind our proposal. Section 5 proposes our alternative indicator to improve procurement spending. Finally, Section 6 concludes.

2 Legislative background

The analysis focuses on public contracts for medical devices awarded in Italy in 2013. Due to the implementation of spending review measures, since July 2012, the public procurement market has faced some new rules that have been implemented. The most relevant for our analysis is the introduction of reference prices for a set of medical devices, both simple (syringes, needles, and dressings) and more complex (prosthesis and coronary stents).[3]

The Italian Anticorruption Authority decided the reference prices based on a statistical analysis that focused exclusively on the price distribution of medical devices computed from a survey sent to a sample of 283 public buyers. The authority then set the 25th percentile as the reference price as a binding price cap.

Some suppliers disputed the introduction of the binding reference prices by the Italian Anticorruption authority and went to court to complain that the classification of the medical devices and the corresponding attribution of the reference prices were done inappropriately. On 2 May 2013, the administrative court in Italy decided in favor of the

[3]See Bucciol et al. (2020) for a detailed discussion of the reference pricing policy.

suppliers, thus invalidating the classification of the reference prices. Binding reference prices became a non-binding benchmark. We will focus on the period in which reference prices were not binding in the first part of our analysis.

Regarding the award of the contracts, there are several different ways in which these contracts are awarded. Contracts in our sample period were subject to the Public Procurement Law in force in Italy until 2016 (*D.Lgs. 163/2006*). Buyers usually use a direct award below contract values of €40,000, thus negotiating directly with their preferred supplier. Above €40,000, more competitive procedures are used, from restricted auctions to open auctions. Direct awards are also allowed, but only upon consultation of at least five potential suppliers. Finally, quantities of medical devices are known *ex-ante* at the time of the tender announcement, and firms then offer a unitary price for these devices. More than 50% of the sample is characterized by contracts worth less than €40,000, which are typically awarded with procedures that ensure the largest discretion to buyers.

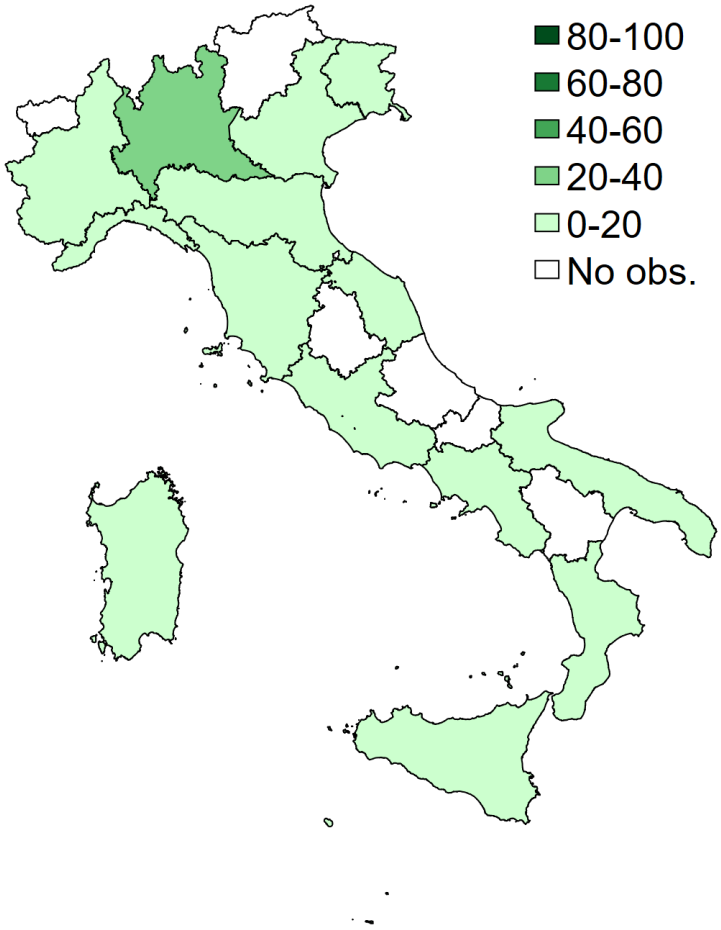
3 Data

Data are obtained from a survey run by the Italian Anticorruption Authority in 2014.[4] The authority sent the questionnaire to a sample of several buyers of medical devices across the country. The buyers reported the unitary prices of the medical devices, the quantities auctioned in the contract, and the contract date. The survey also includes very detailed characteristics of the good, including the exact brand of the good as registered in the database of medical devices stored in the Italian Ministry of Health. A unique characteristic of these data is the availability of information on quantities of devices in the contract and the unit price paid for each device. Note that each observation in the dataset, with a specific unit price and specific quantities, is not a contract by itself. Multiple observations may belong to the same contract. We treat each observation as independent in the analysis.

Figure 1 shows the coverage of the survey. Except for a few regions for which no observations are available, the coverage seems widespread across the entire country, with a relatively high concentration of observations only in the region of Lombardy.

[4]The dataset is publicly available on the website of the Italian Anticorruption Authority. See here.

Figure 1: Survey coverage



Since the survey includes the unique contract ID, we can merge the survey with some additional contract characteristics, such as the value of the contract. These characteristics can be found on the Anticorruption Authority website, where the universe of procurement data is stored.

Table 1 reports summary statistics for the main variables of interest. Quantities seem to vary substantially across contracts. The large heterogeneity in purchases is also reflected in the considerable heterogeneity in contract values, with an average of €72,000 but a standard deviation of almost twice as much. The measure of normalized prices (where we normalized the unit price of the device by its reference price) has a lower degree of variation. It shows, though, that the distribution of unitary prices is skewed with respect to the reference price, with a mean well above the median.

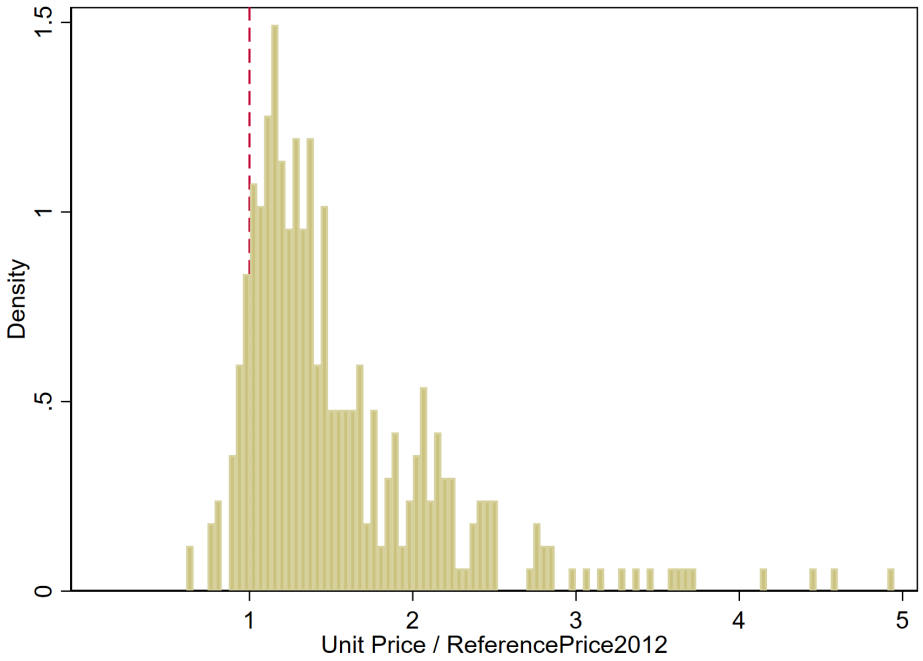
Figure 2 plots the unit prices as a function of the reference prices. It shows that, when non-binding, reference prices set in 2012 do not constitute a relevant benchmark. However, we still do not know from this picture whether these reference prices introduced some distortions, with some buyers referring to this benchmark and not exploiting the ability to get bulk discounts.

Table 1: Summary statistics of the main variables

VARIABLES	(1) mean	(2) sd	(3) p10	(4) p50	(5) p90	(6) N
Quantity	80,784	359,593	200	4,400	106,000	409
UnitPrice/RefPrice2012	2.035	2.597	1.009	1.383	2.800	409
Value Contract (€)	72,059	124,858	1,716	31,547	180,000	409

Quantity are the quantities of medical devices in the contract. *UnitPrice/RefPrice2012* is the unitary price divided by the reference price established in 2012.

Figure 2: Distribution of prices divided by the non-binding reference price



This figure plots the distribution of the unit prices, normalized by the reference price in place since 2012, of the devices in the sample. The reference price was non-binding in the sample of purchases that we consider. The dashed line represents a normalized price equal to 1, meaning when the unit price equals the reference price. Bin size equal to 100.

Figure 3 shows the negative relationship between the logarithm of quantities in the contract and the logarithm of price, while Table 2 shows the results of a regression of the logarithm of unit prices paid and the logarithm of the quantities purchased. The coefficient represents an elasticity. The negative relationship reaches 0 and becomes weakly significant if we include device and buyer fixed effects. This is because there is little variation left once we control for device and buyer fixed effects. Still, this analysis shows that quantities are a relevant variable that explains unit prices once we control and do not control for device effects. Ignoring this relationship would probably create distortions.

Figure 3: Elasticity price-quantities

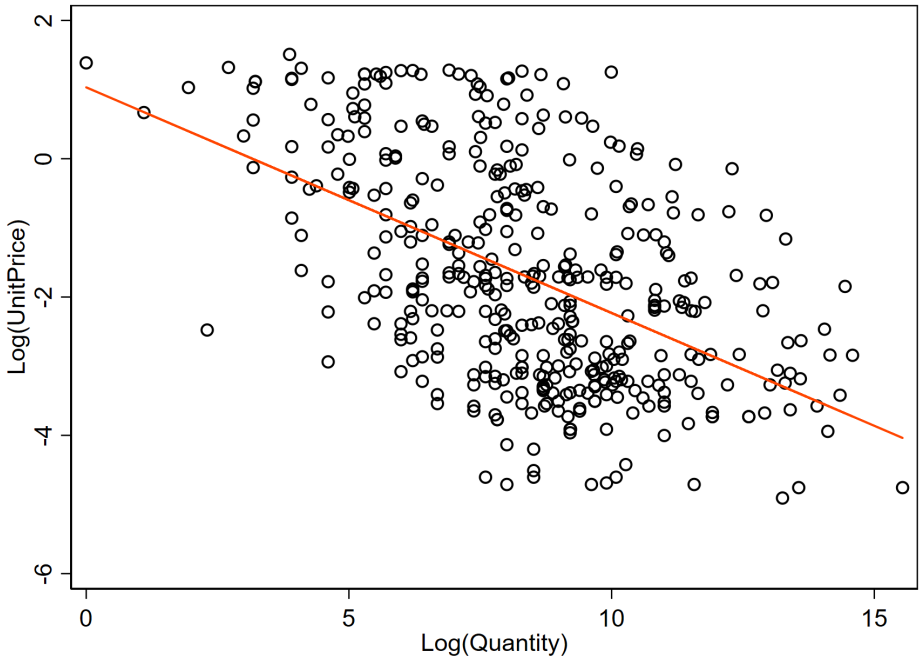


Table 2: Relationship between quantities in the contract and unitary prices

	(1)	(2)	(3)
VARIABLES	Log(UnitPrice)	Log(UnitPrice)	Log(UnitPrice)
Log(Quantity)	-0.3263***	-0.0764***	-0.0244*
	(0.052)	(0.010)	(0.014)
Observations	409	408	395
R-squared	0.264	0.959	0.979
DeviceID FE	No	Yes	Yes
Buyer FE	No	No	Yes

Standard errors are clustered at the device level.

4 Motivating facts

We aim to document whether non-binding reference prices produce distortions in the market. For that, we rely on a test. The logic behind this test is that the relationship between prices and quantities (in log) should not be discontinuous around prices close to the reference price. Thus, conditional on unit prices being close to the reference price, the logarithm of quantities should not be different.[5]

[5]We follow the approach by Kawai et al. (2021) who test collusion using an RDD looking at discontinuities in firms' characteristics between marginal winners and losers bidding for construction contracts.

The treatment assignment, defined as D_a is the following:

$$D_a = \begin{cases} 1, & \text{if } UnitPrice \geq ReferencePrice2012 \\ 0, & \text{if } UnitPrice < ReferencePrice2012 \end{cases}$$

The regression model is the following:

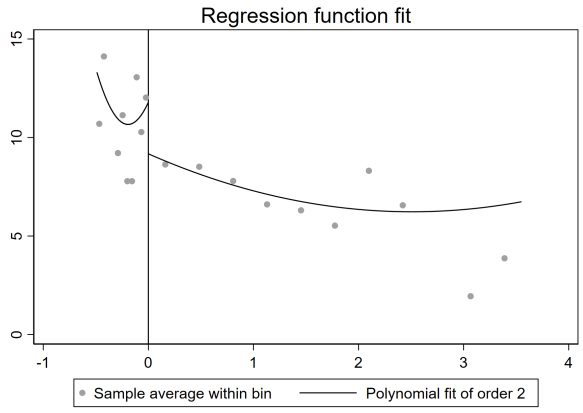
$$log(Quantity_a) = \alpha + f(X_a) + \beta D_a + \epsilon_a \tag{1}$$

where, by rearranging and taking logs, $D_a = 1$ if $log(\frac{UnitPrice}{ReferencePrice2012}) > 0$ and $X_a = log(\frac{UnitPrice}{ReferencePrice2012})$. We denote as running variable $log(UnitPrice) - log(RefPrice2012)$, where $UnitPrice$ is the unitary price at which the contract is awarded, and $RefPrice2012$ is the reference price of the year 2012. The treatment is a dummy indicating whether the contract is awarded at a price above or below the reference price, and the regression discontinuity design is sharp. β will thus indicate the local average treatment effect around the cutoff. If there are no discontinuities, we expect this local average treatment effect to be not statistically different from 0. We thus test the null $\beta = 0$ against the alternative $\beta \neq 0$. We estimate β using a second- and first-degree polynomial function.

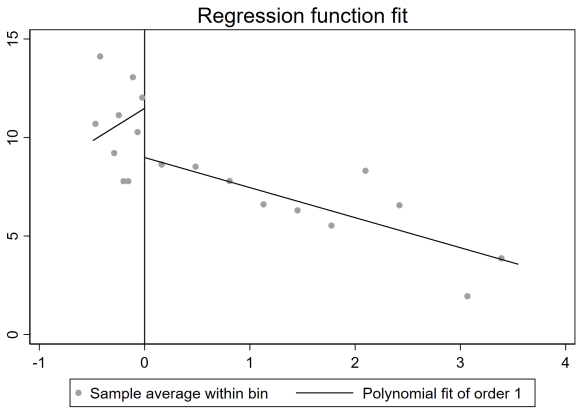
Table 3 shows the estimate of β on our sample of contracts. The gap in the logarithm of quantities across contracts awarded at a price marginally above and marginally below the reference price is negative and significant. Thus, the null hypothesis that contracts marginally above and marginally below the reference price do not differ in the logarithm of quantities can be rejected.

Figure 4: RDD plots of equation 1

(a) Quadratic



(b) Linear



Here, we do not test for lack of competition but only for the discontinuity in the elasticity between quantities and prices around the reference price.

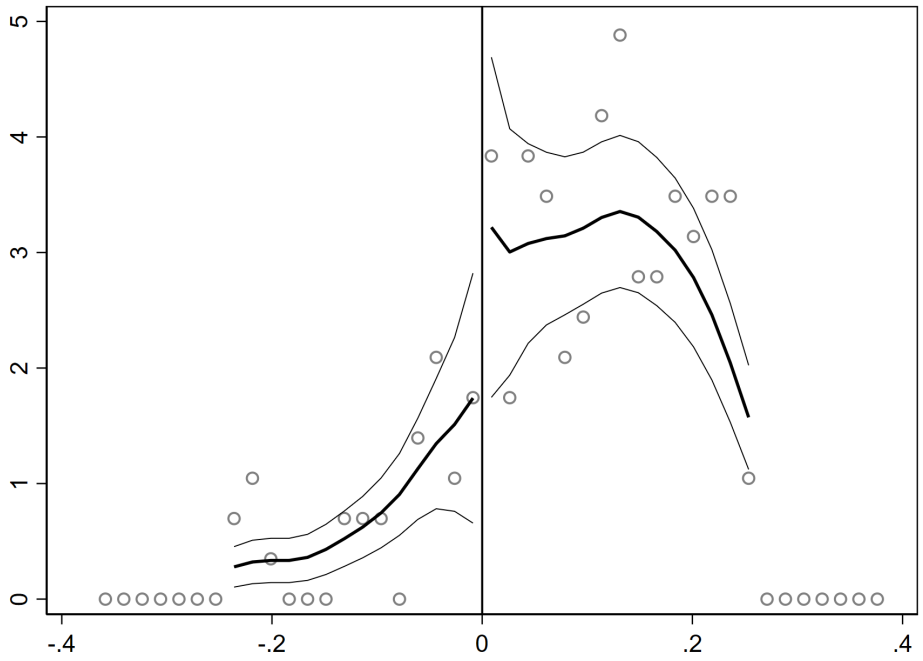
Table 3: RDD results

VARIABLES	(1) Log(Quantity)	(2) Log(Quantity)
β	-3.754**	-2.668**
	(1.712)	(1.190)
Observations	409	409
Covariates	NO	NO
Mean Quantity	80,784	80,784
Bandwidth	0.118	0.0862
Order polyn.	2	1

Standard errors are clustered at the device level. Column 1 reports the estimation using a quadratic polynomial. Column 2 reports the estimation using a linear polynomial. All estimates are based on triangular kernel and optimal bandwidth using a CER-optimal bandwidth selector.

To test the validity of the RDD design, we test if there exists manipulation of the running variable around the reference price. The McCrary test in Figure 5 shows no discontinuities around the reference price. The t-statistic is equal to 1.29.

Figure 5: McCrary test



This figure plots the McCrary test of the running variable ($log(\frac{UnitPrice}{ReferencePrice2012}) \in [-.25, .25]$).

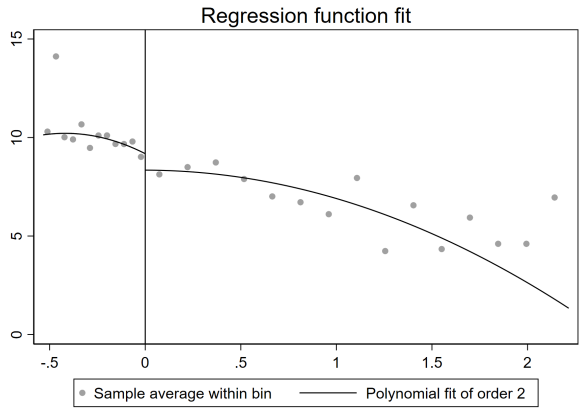
As a robustness check to the test, we propose the following: what if the reference price was set to another level? To do so, we take the future reference price that was then binding and adopted only in March 2016. This serves as a placebo test. If the reference

price is fixed to a future price level that was not observed at the time of the survey, the relationship between the logarithm of quantities and the logarithm of prices should be the same around this artificially constructed cutoff.

Table 4 shows that we do not reject null, meaning that the local average treatment effect is not statistically different from 0. The graph in Figure 6 shows that the discontinuity at the fictitious cutoff is not observed.

Figure 6: RDD plots of equation 1

(a) Quadratic



(b) Linear

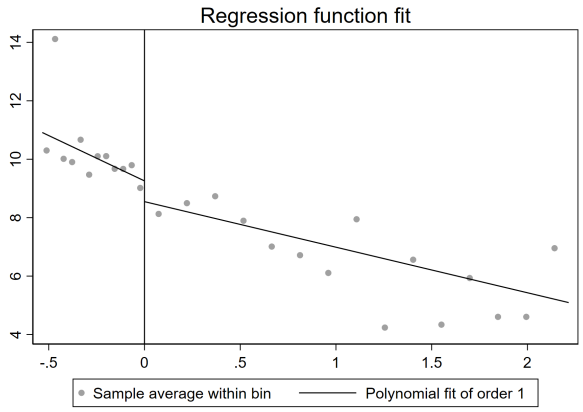


Table 4: RDD results

	(1)	(2)
VARIABLES	Log(Quantity)	Log(Quantity)
β	-0.169	-0.494
	(1.103)	(0.966)
Observations	409	409
Covariates	NO	NO
Mean Quantity	80,784	80,784
Bandwidth	0.215	0.172
Order polyn.	2	1

Standard errors are clustered at the device level. Column 1 reports the estimation using a quadratic polynomial. Column 2 reports the estimation using a linear polynomial. All estimates are based on triangular kernel and optimal bandwidth using a CER-optimal bandwidth selector.

5 An alternative spending review policy in public procurement

The first part of our analysis motivated us to propose an indicator that could help public buyers reduce the prices they pay for medical devices. This indicator is the elasticity of prices to quantities in the contract. Releasing the information for each device to each public buyer on how good the agencies were in getting lower prices for a given quantity can help them improve their procurement performance.

To show the potential effects of this indicator on public savings, we first analyze the period in which reference prices were not binding and estimate the elasticities on those purchases. We do so by estimating the following regression on each device group separately:

$$log(UnitPrice_{ad}) = \delta_0 + \delta_1 log(Quantity)_{ad} + \epsilon_{ad} \tag{2}$$

where $log(UnitPrice_{ad})$ is the logarithm of the unit price of device d in observation a, $log(Quantity_{ad})$ is the logarithm of the quantities purchased of the device. We are interested in the coefficient δ_1, which represents the elasticity of prices to quantities. The estimated coefficient $\hat{\delta_1}$ is equal to

$$\hat{\delta_1} = \frac{dP}{dQ}\frac{Q}{P} \tag{3}$$

From equation 2 we have thus obtained $\hat{\delta_1}$ and $\hat{\delta_0}$. We can then use the two estimated coefficients to find the counterfactual price that we could observe in the data on purchases before May 2013 if the bargaining ability of the buyers had been exploited. We compute the counterfactual unit price as follows:

$$log(UnitPriceCf_{ad}) = \hat{\delta_0} + \hat{\delta_1} log(Quantity)_{ad} \tag{4}$$

where $log(UnitPriceCf_{ad})$ is the logarithm of the counterfactual unit price. Thus:

$$UnitPriceCf_{ad} = \exp(log(UnitPriceCf_{ad})) \tag{5}$$

If these elasticities could be enforced, we would have observed a price lower than the one at which devices were effectively purchased for 55% of these purchases. Overall, buyers could have reached total savings equal to 17%.

The suggested methodology could imply savings by acting through two main leverages. First, there is no need to publish any information on prices paid, thus making it impossible for firms to price at the focal point. Second, this information could be retained only by buyers and thus substantially mitigate the information asymmetries they have with respect to the suppliers.

6 Conclusion

We proposed a new methodology to help public buyers reduce their procurement spending. We applied the analysis to the public procurement market for medical devices, using a survey from the Italian Anticorruption Authority reporting contracts awarded by several Italian buyers in 2013.

After documenting that non-binding reference prices have implied some distortions because they do not consider the relationship between prices paid and quantities purchased, we presented our methodology, which we applied to a sample of purchases in the same survey. We have shown that total savings reached 17%

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