Centralized Procurement and Delivery Times: Evidence from a Natural Experiment in Italy

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Motivation

Centralized procurement is the purchase of goods, works or services by a central purchasing body acting as contracting authority on behalf of one (or more) local administrations (in Italy, Consip is a central purchasing body)

Evidence is that centralized procurement reduces **prices**

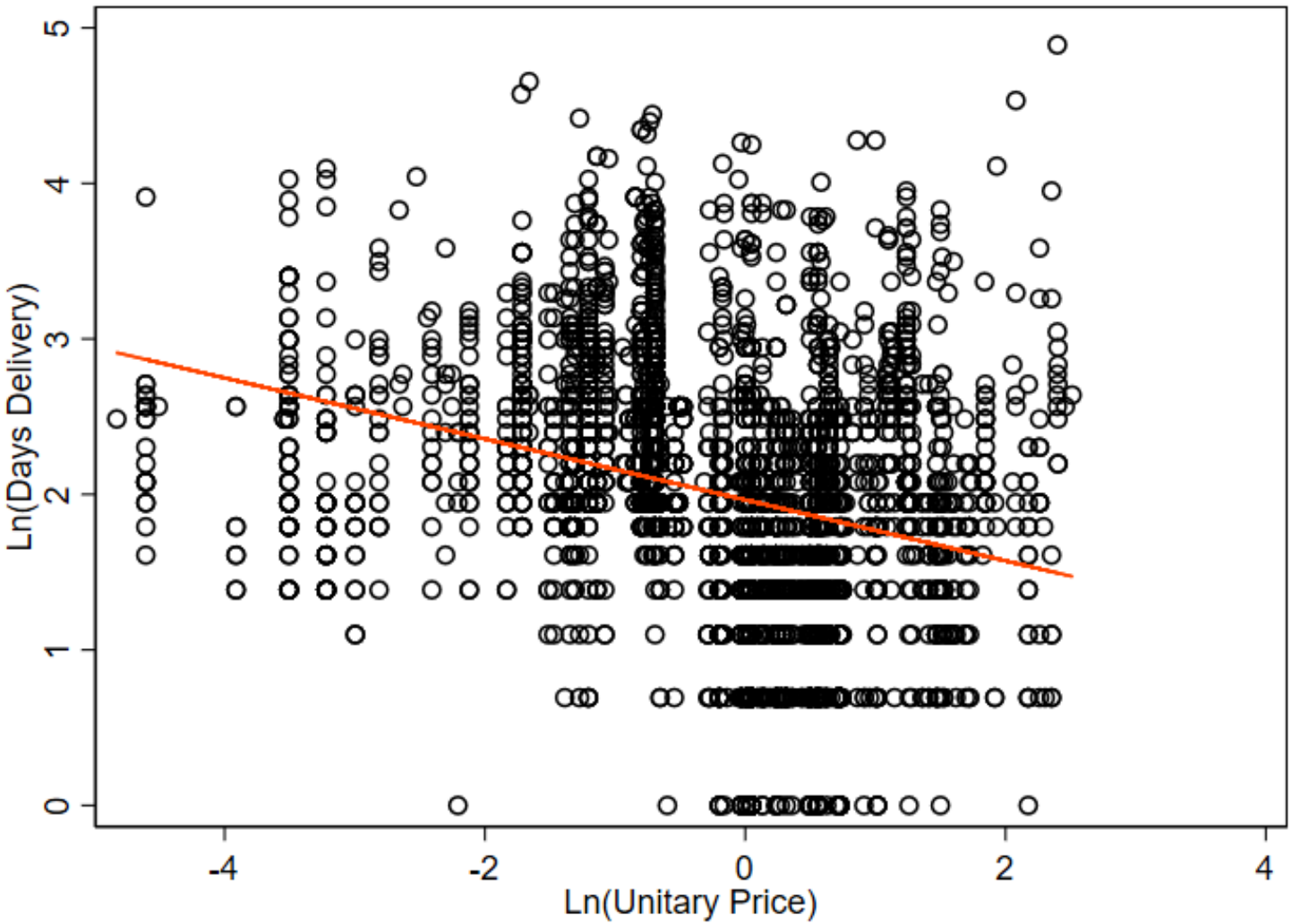
- Intuition: bulk purchasing (see Bandiera et al., 2009)

Price reduction might come at a cost of longer delivery times but data on delivery times are not often available

- OECD (2011) objects that centralization may be associated with longer delivery times
- We observe a negative relationship between prices paid and delivery times of medical devices in healthcare (correlation $\neq$ causation)

Data suggest trade-off prices-delivery times

Figure 1: Unitary prices of medical devices and delivery times (in logs)



This paper

Objective

- Document the impact that **centralized** procurement has on prices and timeliness of the deliveries of the purchased goods

Approach

- Use staggered implementation of centralization by the Italian government
  - Identification: post-2016 the purchase of a subset of devices was **mandated** to be **centralized** *(Difference-in-Difference)*
- Use order-level data on purchases of homogeneous items by Italian public health units in one single region
  - medical devices: syringes, needles, dressings (treated) and sutures (control)
  - we observe prices and timeliness of the deliveries of each order (together with info on buyers and suppliers)

Identification strategy

Figure 2: Treated/Centralized: syringe

Figure 3: Control/Not-Centralized: sutures

Preview of the findings

Mandatory centralized PP generated a trade-off between prices and delays

- Reduced prices (-15%) and increased delivery times (+20%)
- No effects on quantities demanded by hospitals

We recognize that the treatment might not be randomly assigned but

- Policy of central government (exogenous with respect to the only region for which we have data)
- Identification strategy supported by the analysis of pre-trends

Data allows to inspect the mechanisms

- Bulk purchasing
- Lower number of suppliers for the same level of demand

Outline

- Literature review
- Institutional background, data and sample
- Identification strategy: difference-in-difference
- Main results on prices and delays
- Mechanism underlying the decrease in prices and increase in delays
  - Quantities
  - Competition at the contract awarding stage
  - Market structure
- Conclusion

Related literature

- Centralized procurement reduces prices
  - Bandiera et al. (2009), Albano and Sparro (2010), Schotanus et al. (2011), Walker et al. (2013), Castellani et al. (2020), Ferraresi et al. (2020) $\rightarrow$ no info on timeliness of the deliveries
- Procurement in healthcare
  - Grennan (2013), Grennan and Swanson (2019), Bucciol et al. (2020), Dubois et al. (2019) $\rightarrow$ no ex-post info and no natural experiment on centralized procurement
- Discretion in public procurement
  - Coviello et al. (2018), Decarolis et al. (2020) $\rightarrow$ these studies deal with public works and services
  - Bandiera et al.(2021): experiment introducing discretion and incentives to bureaucrats in public procurement of homogeneous goods $\rightarrow$ prices go down without reduction in quality

Our contribution

- Analysis of the relationship between prices and higher delays (a dimension of quality) in the context of homogeneous items
- Mechanism behind higher delays and increase in prices looking not only at buyer but also supply side
- Unique setting where we match order-level data and contract-level data (multiple purchase orders can be done using one contract)
- Centralization experiment offers quasi-experimental variation

The data

We collect and merge the following three datasets:

1. Universe of orders for medical devices in all the public health units in Lazio region (Italy) between 2015 and 2018
   - unitary price, quantities ordered
   - total value of the order
   - identity of the buyer and the supplier
   - date of the order
   - product identifier
   - full description of the medical device
   - device ID
   - contract ID
   - date of delivery and quantities delivered
2. National Agency for Regional Health Services list of homogeneous medical devices matchable with **device ID** to order-level data
3. Data on contract level outcomes matchable with **contract ID** to order-level data (all contracts above €40,000, minimum threshold for contract info communication)

Comparable medical devices

- Medical devices in our sample are very homogeneous and simple
- Medical devices subject to the centralization experiment have been classified in classes of items by the National Agency for Regional Health Services (Agenas)
- This classification helped the Italian anti-corruption authority in setting reference prices starting from 2012
- We drop 39 of these classes that have been exposed to another reform in March 2016 (reference pricing)

Details of the centralization experiment

- Starting 1st January 2016, Italian public health units **have to procure** a specific sub-set of their medical devices using a set of centralized purchasing entities (national and/or regional purchasing agencies called *Soggetti Aggregatori*, i.e. demand aggregators) acting as auctioneers
- Regional/national *Soggetti Aggregatori* started directly running large auctions to award contracts to procure syringes, needles, and dressings
- Above €40,000 euro, ANAC DOES NOT release the contract ID if health units buy on their own (except under emergency situations)
- Public health units are exempted for small contracts with a value below €40,000.

Legislation

Details of the centralization experiment

Figure 4: Pre 2016

Contract values (€)	<40,000	≥40,000
Syringes, needles,dressings	optional	optional
Sutures	optional	optional

Figure 5: Post 2016

Contract value (€)	<40,000	≥40,000
Syringes, needles, dressings	optional	mandatory
Sutures	optional	optional

How centralization works?

Open auctions (national and regional agencies)

- The centralized agency acts as auctioneer and awards a public contract using open procedures on behalf of one or more public administrations

Framework agreements (national and regional agencies)

- General contracts between a procuring entity and a supplier for the delivery of goods and services within a certain time frame at specified price and conditions
- Public bodies can buy the goods or services specified in the contract, at the terms and conditions established
- The agency does not commit to buy any units, so that if no public body places an order, no single unit is sold.

Electronic market (national centralized agency ONLY)

- Suppliers and buyers are connected through a platform provided by the agency which acts as intermediary

Devices relevant to the analysis

Figure 6: Devices subject to centralization

Commodity study	Threshold (€)	Dpcm
SPECIFIC HEALTHCARE EXPENDITURE - GOODS		
Medicines	40,000	2016
Vaccines	40,000	2016
Stent	Community threshold	2016
Incontinence aids	40,000	2016
Hip replacement	Community threshold	2016
General dressings	40,000	2016
Defibrillators	Community threshold	2016
Pacemaker	Community threshold	2016
Needles and syringes	40,000	2016
Gloves (surgical and non-surgical)	40,000	2018
Sutures	40,000	2018

Source: Italian National Procurement Agency (*Consip*)
`https://www.consip.it/media/approfondimenti/consip-nel-sistema-nazionale-degli-acquisti-pubblici`

Devices relevant to the analysis

Figure 7: Devices subject to centralization

Commodity study	Threshold (€)	Dpcm
SPECIFIC HEALTHCARE EXPENDITURE - GOODS		
Medicines	40,000	2016
Vaccines	40,000	2016
Stent	Community threshold	2016
Incontinence aids	40,000	2016
Hip replacement	Community threshold	2016
General dressings	40,000	2016
Defibrillators	Community threshold	2016
Pacemaker	Community threshold	2016
Needles and syringes	40,000	2016
Gloves (surgical and non-surgical)	40,000	2018
Sutures	40,000	2018

- These categories are all very general
- Syringes can be ml 5, ml 10, dressings could be 10X10, 20X20 etc.
- We thus take only devices which are homogeneous

Devices included in the analysis

Figure 8: Devices subject to centralization. Medical devices analyzed in red.

Commodity study	Threshold (€)	Dpcm
SPECIFIC HEALTHCARE EXPENDITURE - GOODS		
Medicines	40,000	2016
Vaccines	40,000	2016
Stent	Community threshold	2016
Incontinence aids	40,000	2016
Hip replacement	Community threshold	2016
General dressings	40,000	2016
Defibrillators	Community threshold	2016
Pacemaker	Community threshold	2016
Needles and syringes	40,000	2016
Gloves (surgical and non-surgical)	40,000	2018
Sutures	40,000	2018

- The underlined categories contain homogeneous goods and have same thresholds
- *Gloves*,*incontinence aids*, *pacemaker* and *defibrillators* never homogeneous
- *Drugs* and *vaccines* are not medical devices
- *Stent* and *hip replacements* were homogeneous but they have different threshold of centralization

Buyers

Local Health Unit (Azienda Sanitaria Locale)

- Public body of the Italian public administration, providing health services such as service for pathological addictions, clinics for specialist examinations, home care and assistance, vaccinations, blood tests

Hospital Unit (Azienda Ospedaliera)

- "Standard" hospitals

Institutes for Hospitalization and Care with Scientific Purposes (IRCCS)

- Hospitals which address specific diseases (infectious diseases, cancer) having also research purposes

From simplicity, I call all these buyers "hospitals" from now on

Identification strategy

Difference-in-Difference research design

Starting 1st January 2016, the purchase of a sub-set of medical devices was mandated by the government to be centralized

Because of data disclosure requirements we focus on contracts above €40,000 (we thus exclude orders from contracts below €40,000)

Treated items are syringes, needles, and dressings

- They are subject to the centralized experiment since January 2016 for contract values above €40,000

Control items are sutures

- They are subject to the centralized experiment since July 2018 for contract values above €40,000

Is treatment randomly assigned?

Treated and controls in 2012 identified as goods with "high impact on public expenditure"

- After a classification by an external authority, the Italian Anticorruption authority identified in 2012 and set reference prices on those items in order to limit public expenditure
- The reference prices were then invalidated by an administrative court in 2013 (Bucciol et al.,2020)
- Sutures (control) thus had high impact on public expenditure as syringes, dressings, needles (treated) but centralization in 2016 only involved syringes, needles and dressings (differently from reference prices in 2012)

Level of decision of policy change

- The centralization policy has been decided by central government
- We look at buyers in one Italian region only

Main Empirical Model

$$Ln(Y_{odchm}) = \beta_0 + \beta_1 Centralized_d + \beta_2 Post_m + \beta_3 Centralized_d \times Post_m + \\ + \beta_4 Ln(ContractValue)_c + \beta_5 Ln(Q)_{odchm} + \theta_d + \gamma_h + \delta_m + \epsilon_{odchm}$$

- Y_{odchm} are prices and days of delivery for order o, of device d, for contract c, in hospital h in month m
- *Centralized* is a dummy equal to 1 for devices centralized
- *Post* is a dummy equal to 1 if order is issued after January 2016
- $Ln(ContractValue)$ is the log of contract value
- $Ln(Q)$ is the log of quantities ordered
- θ_d are device fixed effects
- γ_h are hospital fixed effects
- δ_m are month fixed-effects
- Note: standard errors are clustered at the device-hospital level

Main outcomes and results

- Unitary prices
- Delays (days between date of the order and date of delivery)
- Leads and lags
  - Test pre trend and dynamic effects of centralization
- Quantile DID for prices and delays
  - Check effect of the policy at different quantiles of the distribution of unitary prices and delivery times

Results: Centralization Reduces Prices but increases Delivery times

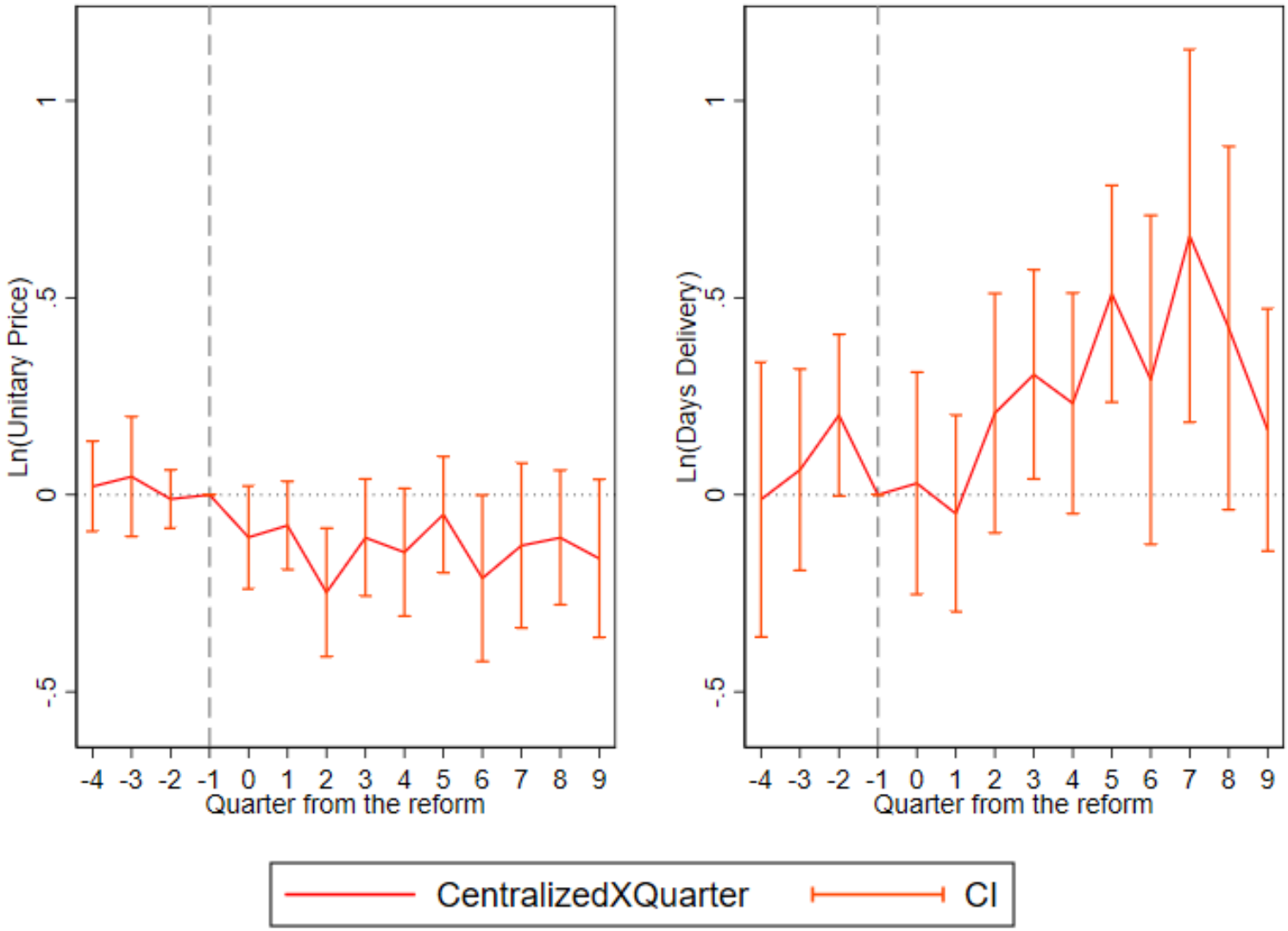
VARIABLES	(1) LogPrice	(2) LogPrice	(3) LogPrice	(4) LogDays	(5) LogDays	(6) LogDays
Centralized×Post	-0.1958	-0.1346*	-0.1457**	0.2723***	0.2065***	0.1963***
	(0.172)	(0.073)	(0.072)	(0.094)	(0.075)	(0.074)
Centralized	-1.1418***			0.7254***		
	(0.185)			(0.098)		
Post	0.0966			-0.1270		
	(0.085)			(0.079)		
Ln(Quantity)			-0.0140			0.0032
			(0.010)			(0.022)
Ln(ValueContract)			-0.0471			-0.0438***
			(0.040)			(0.012)
Observations	3,720	3,720	3,720	3,720	3,720	3,720
DeviceID FE	No	Yes	Yes	No	Yes	Yes
Hospital FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Mean Y Centralization Pre	1.012	1.012	1.012	12.09	12.09	12.09

Test parallel trend pre-reform and dynamic effects of centralization

$$Ln(Y_{odchq}) = \sum_{j=-3}^{8} \theta_j Centralized_d \times Quarter_q + \beta_4 Ln(ContractValue)_c + \\ + \beta_5 Ln(Q)_{odchq} + \theta_d + \gamma_h + \delta_q + \epsilon_{odchq}$$

- j are quarters from the reform
- *Centralized* is a dummy for devices centralized
- $Ln(ContractValue)$ is the log of contract value
- $Ln(Q)$ is the log of quantities ordered
- θ_d are device fixed effects
- γ_h are hospital fixed effects
- δ_q are quarter fixed effects
- Quarter before the policy is the base group
- Specification used to test the parallel trend assumption

Effects are persistent and not anticipated

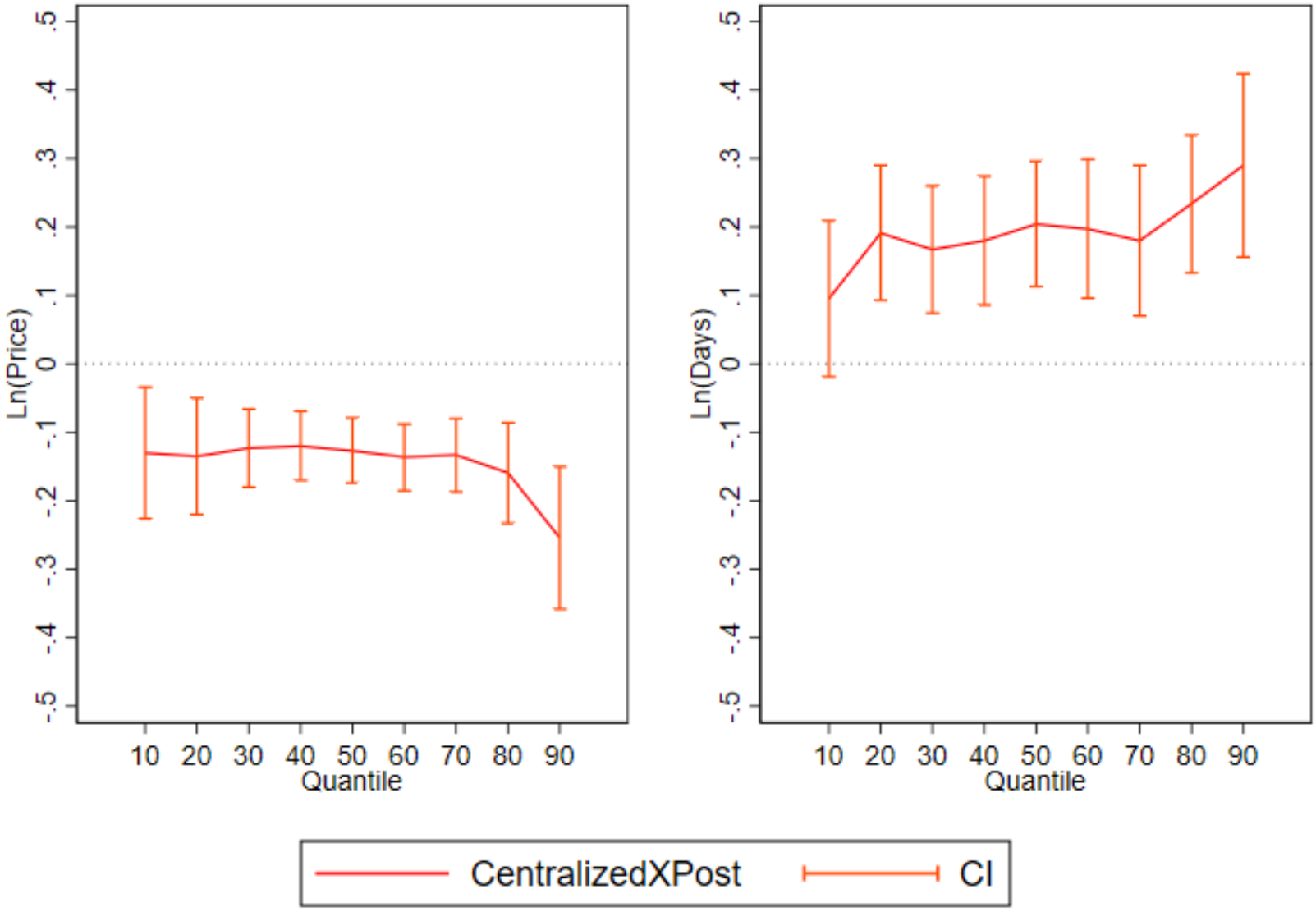


Quantile DID

$$Q_q(Ln(Y_{odchm})) = \beta_{0,q} + \beta_{1,q} Centralized_d + \beta_{2,q} Post_m +$$
$$+ \beta_{3,q} Centralized_d \times Post_m + \beta_{4,q} Ln(ContractValue)_c + \beta_{5,q} Ln(Q)_{odchm} +$$
$$+ \theta_d + \gamma_h + \delta_m + \epsilon_{odchm}$$

- q is the q-th quantile, with $q = 10, ..., 90$
- Y_{odchm} are prices, quantities and days of delivery for order o, of device d, contract c in hospital h in month m
- $Centralized$ is a dummy equal to 1 for devices centralized
- $Post$ is a dummy equal to 1 if order is issued after January 2016
- $Ln(ContractValue)$ is the log of contract value
- $Ln(Q)$ is the log of quantities ordered
- θ_d are device fixed effects
- γ_h are hospital fixed effects
- δ_m are month fixed-effects

Quantile DID



Standard errors obtained using 200 bootstrap replications

Quantile DID

Figure 9: Coefficients of *Centralized* × *Post* at each quantile q

	(1)	(2)
Dep.Variable	Ln(Price)	Ln(Days)
q10	-0.130***	0.0955
	(0.0491)	(0.0582)
q20	-0.135***	0.191***
	(0.0433)	(0.0505)
q30	-0.123***	0.167***
	(0.0289)	(0.0475)
q40	-0.120***	0.180***
	(0.0257)	(0.0480)
q50	-0.127***	0.204***
	(0.0242)	(0.0467)
q60	-0.136***	0.197***
	(0.0249)	(0.0516)
q70	-0.133***	0.180***
	(0.0272)	(0.0560)
q80	-0.159***	0.234***
	(0.0373)	(0.0513)
q90	-0.254***	0.290***
	(0.0531)	(0.0682)
DeviceID FE	Yes	Yes
Hospital FE	Yes	Yes
Time FE	Yes	Yes
Observations	3720	3720

Mechanism 1: bulk purchasing

- Do purchased quantities per contract increase?
  - We check this hypothesis by collapsing data by contract-device (a contract might involve the award of different homogeneous devices)
- To rule out the hypothesis of a demand shock, demand by hospitals per device should not change
  - We check this hypothesis by collapsing data by device-hospital-month

Bulk purchasing and absence of a demand shock

	(1)	(2)	(3)	(4)
Dep.Var.	Ln(Tot.Q.ContractDevice)		Ln(Tot.Q.HospitalMonth)	
CentralizedXPost	2.5912***	2.0019***	-0.2821	-0.0800
	(0.541)	(0.624)	(0.257)	(0.126)
Centralized	0.2988		0.8664***	
	(0.414)		(0.316)	
Post	-2.5809***	-2.5011***	0.2415*	
	(0.357)	(0.495)	(0.131)	
Observations	182	182	1,474	1,474
DeviceID FE	No	Yes	No	Yes
Hospital FE	No	No	No	Yes
Time FE	No	No	No	Yes
Mean Y Centralization Pre	56414	56414	8071	8071

Significantly more quantities per contract-device, consistent with bulk purchasing

Mechanism 2: competition

Check competition at contract level:

- Number of bidders (not always reported in the data)
- Open auctions
- Value contract

Results underline an increase (not significant) in competition

Dep.Var.	(1) N-bidders	(2) OpenAuction(0/1)	(3) Ln(ValueContract)
Centralized×Post	1.4234	0.0979	0.9020
	(1.071)	(0.243)	(0.701)
Centralized	-0.7091	-0.2765*	-0.7630
	(0.546)	(0.140)	(0.514)
Post	0.5333	-0.1039	-0.9013
	(0.868)	(0.211)	(0.636)
Observations	54	94	94
DeviceID FE	No	No	No
Hospital FE	No	No	No
Time FE	No	No	No
Mean Y Centralization Pre	1.091	0.542	475447

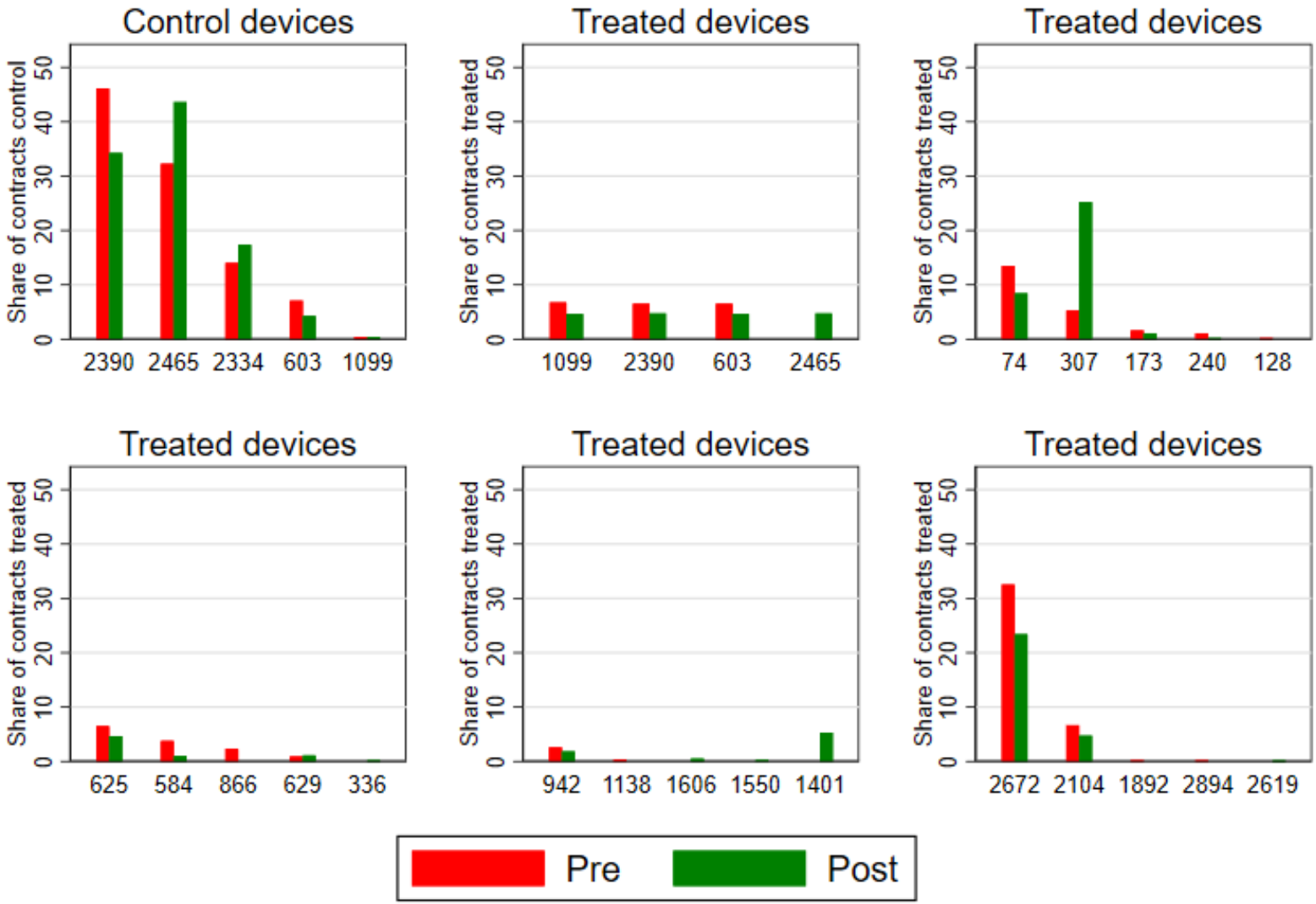
Although coefficients underline higher competition in terms of number of bidders and awarding procedures, the changes are not significant

Mechanism 3: winners' identities and supply concentration

- Market structure
- Market share of producers vs. distributors
- Number of suppliers

Identity of winners changes in the treated market

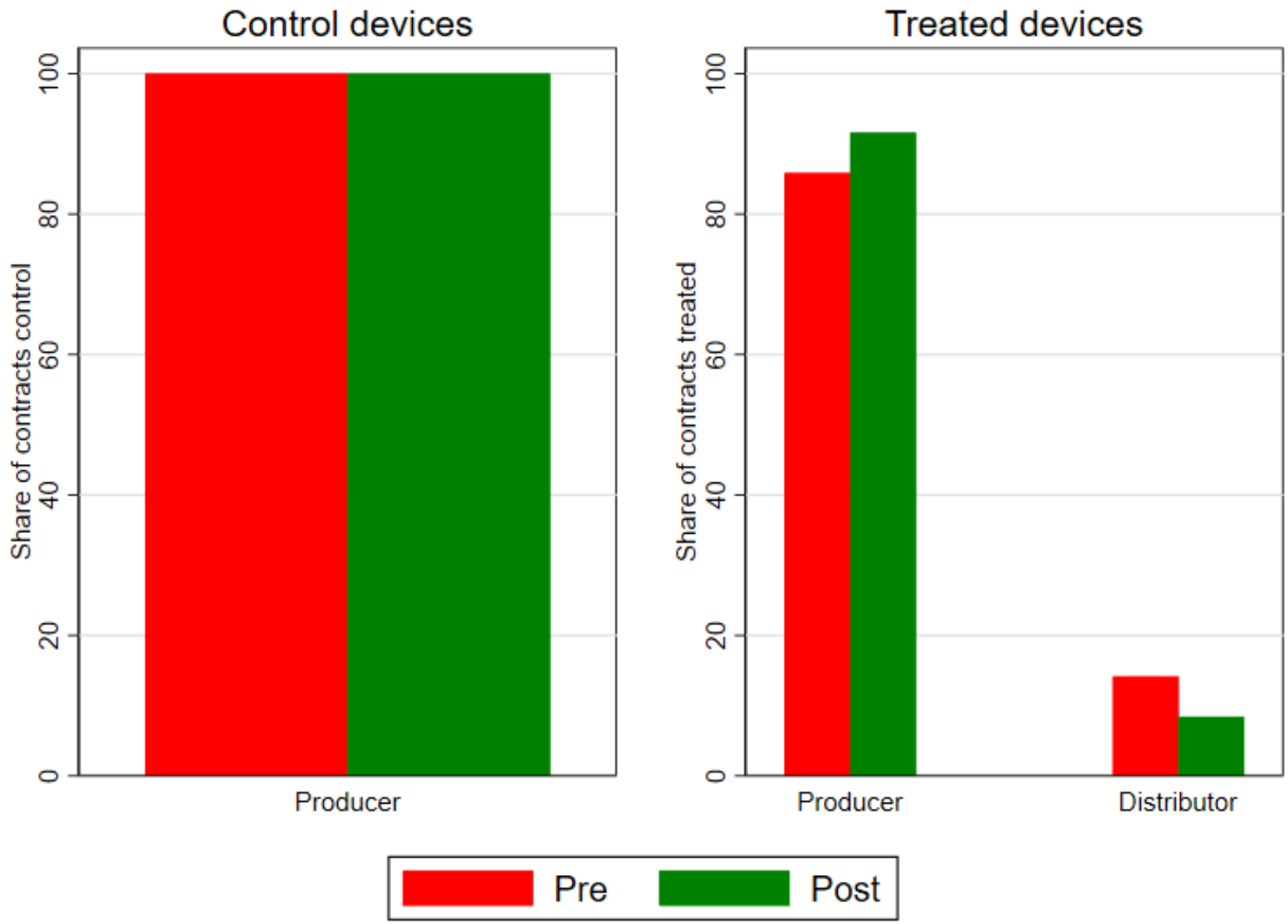
First 2 histograms contains firms in both markets (2390,2465,1099,603)



For treated devices, we exclude firms with less than 1% in market shares before and after

A small increase in market share for producers

Figure 10: Market shares producers and distributors by market



Monthly demand does not change but significantly lower number of suppliers

	(1)	(2)	(3)
Dep.Var.	N.OrdersMonth	Ln(Tot.Q.Month)	N.SuppliersMonth
CentralizedXPost	-1.9833	-0.0551	-2.2833***
	(7.345)	(0.255)	(0.777)
Centralized	14.4167**	3.0026***	11.2500***
	(6.685)	(0.213)	(0.712)
Post	-18.5000***	-0.2485	-0.9167***
	(4.953)	(0.159)	(0.287)
Observations	84	84	84
DeviceID FE	No	No	No
Hospital FE	No	No	No
Time FE	No	No	No
Mean Y Centralization Pre	65.42	266343	14.67

External validity: all devices and drugs

Figure 11: Devices and drugs subject to centralization

Commodity study	Threshold (€)	Dpcm
SPECIFIC HEALTHCARE EXPENDITURE - GOODS		
Medicines	40,000	2016
Vaccines	40,000	2016
Stent	Community threshold	2016
Incontinence aids	40,000	2016
Hip replacement	Community threshold	2016
General dressings	40,000	2016
Defibrillators	Community threshold	2016
Pacemaker	Community threshold	2016
Needles and syringes	40,000	2016
Gloves (surgical and non-surgical)	40,000	2018
Sutures	40,000	2018

- We include all devices in the treated category, with gloves and sutures in the control group
- Instead of 100 fixed effects, we have only 11 (macro-categories)
- Example: here device FE = syringe FE, in previous analysis device FE = syringe ml5 FE, syringe ml10 FE, etc.

Limitations to the external validity

- Community threshold for centralization of some devices is different and changed slightly during sample period (stent, hip, pacemaker, defibrillators)
  - Communitary threshold from €207,000 to €209,000 from January 2016
  - We keep contracts above €209,000 for those devices
- Some devices are not "homogeneous"
  - This might represent a problem for unitary price regression
  - Less of a problem for delays since the outcome is measured at order level

Results hold for all devices

- Our results are also valid for all macro-categories of goods (regardless of their homogenization)

	(1)	(2)	(3)	(4)	(5)	(6)
Dep.Variable	Ln(Price)	Ln(Price)	Ln(Price)	Ln(Days)	Ln(Days)	Ln(Days)
CentralizedXPost	-0.3261	-0.2098	-0.1851*	0.1292**	0.1450***	0.1442***
	(0.273)	(0.154)	(0.099)	(0.059)	(0.048)	(0.048)
Centralized	1.7433***			-0.0923		
	(0.431)			(0.066)		
Post	0.3127			-0.0572		
	(0.255)			(0.052)		
Ln(Quantity)			-0.4556***			0.0113**
			(0.019)			(0.006)
Ln(ValueContract)			-0.0089			-0.0029
			(0.015)			(0.008)
Observations	133,395	133,349	133,349	133,395	133,349	133,349
DeviceID FE	No	Yes	Yes	No	Yes	Yes
Hospital FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Mean Y Centralization Pre	234.4	234.4	234.4	10.71	10.71	10.71

Why not DDD?

- Below €40,000 sample might be biased since it was discretional to report contract info (as explained by Castellani, Decarolis and Rovigatti (2019))
- Thus, we cannot really implement DDD

Conclusions

- We studied the impact of a centralized procurement experiment in Italy on detailed data on purchases of medical devices
- We analyzed data on prices and waiting times of each device before-after the centralization experiment
- Evidence that the centralization experiment caused a reduction in prices and an increase in waiting times (small in terms of days)
- We also found that with centralization:
  - more quantities per contract (bulk purchasing)
  - the identity of suppliers changes
  - demand does not change but devices are ordered from a lower number of suppliers
- Results hold also for the entire set of macro categories (results on prices should be taken cautiously given lack of homogeneity)
- We are currently studying whether the effect is coming from contracts awarded by local or national agencies or through the electronic market

Relevant legislative sources for this paper

Centralization: categories

- Decree Prime Minister 24/12/2015

List of centralized agencies

- Legislative Decree n. 66/2014, Resolution of the Anticorruption authority July 2015

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