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Savings from public procurement centralization in the healthcare system[☆]

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ABSTRACT

We show that the introduction of the procurement centralization within the regional healthcare systems in Italy reduced per capita health expenditure approximatelyt by 2–8%, without affecting the level of health-related public services. Our results also indicate that the effect is persistent after six years, and is not influenced by the coexistence of other organizational models, such as amalgamation and hybrid systems. Finally, we document that the reduction in public expenditure is effective only in areas characterized by poor quality of institutions, indicating that procurement centralization might be an effective tool to reduce corruption-related inefficiencies in the health sector.

1. Introduction

The provision of health goods has become increasingly important in the era of the global economy, in which international partners – both public and private – have shown an incentive to cooperate to the end of efficiently provide global public goods (Arce and Sandler, 2003).[1] This is particularly relevant for governments in developed countries, where proportional electoral systems are associated with higher levels of health expenditure (Wigley and Akkoyunlu-Wigley, 2011) which in turn call for new and more appropriate organizational models as a way to minimize inefficiencies (Borge and Rattsø, 1997) and costs (Machnes, 1996). This phenomenon has become more pronounced since the Great Recession, when public sector reforms across Europe have been high on the policy agenda to the extent that many tighter fiscal constraints have been introduced (see, among others, the Fiscal Compact). Such a strengthening of the budgetary discipline, while ensuring a satisfactory level of service to the population, requires national governments to adopt several strategies that can be traced back to two main strands (Dimitri et al., 2006).

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[1] The globalisation could also influence the composition of the government budget since political agents might use it as a vehicle to advance their agendas. However, as shown by Dreher et al. (2008) a robust impact of globalization on government expenditures does not appear to exist.

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On the one hand, the aggregation of local entities (such as local governments and/or other public institutions) represents an indirect way of pursuing efficiency gains as it allows scale economies in the provision of public goods to be exploited (Oates, 1972). Nevertheless, the empirical evidence of the effectiveness of the processes of aggregation of public entities in reducing public expenditure has produced mixed results.[2] By way of contrast, the centralization of the purchase of goods and services through the introduction of dedicated national or sub-national agencies, such as Central Purchasing Bodies (CPBs), calls for a more direct form of affecting public expenditure and, for this reason, it has been strongly encouraged across several European countries, including the UK, France, Sweden, Denmark, Austria, and Italy (Dimitri et al., 2006).

The introduction of CPBs, besides scale economies, would indeed ensure a reduction of acquiring costs through the increase in the market power of the buyer (Albano and Sparro, 2010) and by guaranteeing a wider possibility to have access to better resources (Baldi and Vannoni, 2017), which can let the procurers threat the providing firms with alternative purchases, thus leading to more competitive prices (Duggan and Scott Morton, 2010). Furthermore, Bandiera et al. (2009), using a sample of Italian public bodies, find that a national centralized authority can produce a reduction of costs. This is mainly due to the reduction of the so-called 'passive waste', namely either the possibility that public officials do not possess the skill or do not have the incentive to minimize costs, or the single public body has an excessive regulatory burden, making procurement cumbersome and increasing the average paid price. At the same time, centralization also reduces the so-called 'active waste', that is the increase in price due to corrupted public officials who accept bribes in exchange for an increase in the price of products. Along these lines, they show that in Italy, after the introduction of the possibility to buy services and goods through a centralized agency (i.e. Consip), the probability to buy a good or service from Consip increases the higher was the previously paid price. Similarly, Best et al. (2017), relying on Russian data, show that high prices in public procurement are the consequence of the inefficiency of bureaucracy, which would allow the Russian government to save approximately 13 billion USD per year. Yet, centralizing procurement can be a way of removing less effective procurers, as shown by Duggan and Scott Morton (2010). The quality of the procurement can also be determined by the discretion adopted by the public body in buying goods and services, as documented by Baltrunaite et al. (2020).[3]

The large discretion in the process of procurement can be assimilated to a decentralization of the decision-making power: public bodies are allowed to skip the general common rules that must be observed in any standard procurement process. In fact, the adoption of a decentralized procurement system can increase the probability of collusion between procurers and supplying firms (Prud'homme, 1995; Tanzi, 1996) because local officials live close to the citizens, and this contiguity allows local interest groups to facilitate higher levels of corruption, with this effect being an increasing function of the length of the politician in office (Coviello and Gagliarducci, 2017). Interestingly, Baldi and Vannoni (2017), using a sample of Italian hospitals, show that centralization and the establishment of purchasing consortia are effective ways of reducing prices, with this effect being more pronounced when the quality of institution is poor, or corruption is higher. This latter result is widely discussed in the economic literature linking fiscal decentralization and corruption (see, among others, Fisman and Gatti, 2002; Lessmann and Markwardt, 2009; Albornotz and Cabrales, 2013).

While there is a well-established literature on the effect of purchase centralization on private firms,[4] little is still known on its impact on public entities. Thus, we complement the existing literature by studying the impact of purchase centralization of local authorities on their costs and expenditure, relying on a difference-in-differences (DiD) design. We focus on healthcare public expenditure as it represents one of the most relevant public expenditure items within EU countries' budgets. Moreover, we take Italy as case study as in 2006, following the 2004/18/CE Directive, regional Central Purchasing Bodies (called 'Centrali di Committenza Regionali') were introduced in the healthcare system. Italy has a highly decentralized system with public expenditure on health mainly allocated to local entities (i.e. regions) according to a quasi-federal institutional structure introduced in 2001 within the Constitutional Law reform (Ferrè et al., 2014), and most of local health service providers ('Aziende Sanitarie Locali', or 'ASLs') are small and fragmented. Differently from Baldi and Vannoni (2017), who base their analysis on a sample of 52 ASLs focusing on the prices of pharmaceutical products from 2009 to 2012, in this work we investigate the effects of the introduction of CPB on all categories of expenditure by relying on a comprehensive administrative dataset, which allows all the Italian ASLs' balance sheets over the period 2003–2012 to be exploited. We then take advantage of the fact that, although mandatory, the introduction of the CPB did not occur simultaneously in all the regional healthcare systems. Thus, we exploit this timing variation to implement our DiD approach to identify the causal impact of the introduction of regional CPBs on local health expenditure and outcomes.

The main result is that the introduction of a regional CPB is associated with a reduction in ASLs' health expenditure in a range

[2] For instance, while Reingewertz (2012), Blesse and Baskaran (2016), and Ferraresi et al. (2018) find that the effect of amalgamation and/or cooperation led to a reduction in per capita expenditure on aggregated (cooperating) municipalities (respectively for Israel, Germany, and Italy), Moisio and Uusitalo (2013) obtain the opposite result for Finland.

[3] Interestingly, they also document that the presence of procuring agencies increase the choice of politically connected and low-productivity firms, and this result is stronger when the socio-political environment is weak.

[4] Purchase centralization is usually indicated as a lever that can favor the containment of firm's expenditure, both externally within its own reference market, or internally by modifying the purchasing decision-making processes. As for the external level, purchase centralization incentives economies of scale and larger bargaining power resulting from the aggregation of volumes of purchases which can occur when standardization bought goods and services is possible (Tella and Virolainen, 2005; Joyce, 2006; Trautmann et al., 2009). Regarding the internal level, instead, the centralization of purchases can effectively streamline the procurement processes (Karjalainen, 2011), allowing the reduction of single transaction costs by decreasing the number of contracts to be negotiated, implemented and managed. Several works quantify a general reduction in costs typically around 10–15% (Nollet and Beaulieu, 2003), although differentiated by economic sector. Concerning the healthcare, Muse and Associates (2000) estimate the savings resulting from the centralization of purchases between 10 and 15% within the American healthcare industry, while Cleverley and Nutt (1984) find a saving due to joint purchases by hospitals between 12 and 25%.

Table 1
EU total Government Expenditure by category as a % of GDP and EU local Government Expenditure by category as a % of GDP.

Government (G) and Local (L) Expenditure	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L
Health	6.2	1.4	6.4	1.5	6.4	1.5	6.5	1.4	6.6	1.4	6.5	1.4	6.7	1.5	7.4	1.6	7.3	1.6	7.1	1.6	7.2	1.5	7.2	1.6	7.2	1.5	7.2	1.5
Social protection	18	2.2	18	2.2	18	2.3	18	2.3	17	2.3	17	2.3	18	2.3	19	2.5	19	2.6	19	2.6	19	2.6	20	2.7	19	2.7	19	2.7
General Public Services	6.8	1.6	6.6	1.6	6.5	1.6	6.5	1.6	6.3	1.6	6.3	1.6	6.5	1.6	6.7	1.8	6.7	1.7	6.8	1.6	6.9	1.6	6.9	1.6	6.7	1.6	6.2	1.5
Economic Affairs	4.1	1.4	4.2	1.5	4.2	1.5	4.2	1.4	4.2	1.4	4.0	1.4	4.6	1.5	4.9	1.6	5.1	1.6	4.5	1.5	4.6	1.5	4.3	1.5	4.3	1.4	4.3	1.4
Education	5.1	2.0	5.1	2.0	5.0	2.0	5.0	2.0	5.0	2.1	4.9	2.0	5.0	2.0	5.3	2.1	5.3	2.1	5.1	2.1	5.0	2.0	5.0	2.0	5.0	1.9	4.9	1.9
Others	5.8	2.2	6.0	2.2	5.9	2.2	6.0	2.3	6.1	2.3	6.0	2.3	6.1	2.3	6.5	2.5	6.2	2.4	5.9	2.3	5.8	2.3	5.7	2.1	5.6	2.1	5.6	2.0

Note: Category “others” includes Defence, Public order and safety, Environment protection, Housing and community amenities, Recreation, culture and religion.

Table 2
Italy total Government Expenditure by category as % of GDP and Italy total Local Expenditure by category as % of GDP.

Government (G) and Local (L) Expenditure	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L	G	L
Health	6.3	6.1	6.3	6.1	6.6	6.5	6.8	6.7	6.9	6.8	6.7	6.6	7.0	6.9	7.5	7.3	7.4	7.3	7.1	7.0	7.2	7.0	7.2	7.0	7.2	7.0	7.1	7.0
Social protection	17	0.6	17	0.7	17	0.7	17	0.6	17	0.7	18	0.7	18	0.7	20	0.8	20	0.8	20	0.8	21	0.8	21	0.8	21	0.7	22	0.7
General Public Services	9.5	2.2	9.2	2.3	8.8	2.2	8.7	2.2	8.4	2.3	8.6	2.1	8.9	2.1	8.6	2.6	8.3	2.2	8.6	2.0	9.4	2.0	9.1	2.0	8.9	2.1	8.4	2.1
Economic Affairs	4.5	2.3	4.4	2.3	4.2	2.4	4.2	2.3	5.1	2.3	4.2	2.2	4.0	2.2	4.7	2.4	4.2	2.3	4.2	2.2	4.1	2.1	3.9	2.1	4.1	2.0	4.1	1.9
Education	4.5	1.2	4.6	1.2	4.4	1.2	4.5	1.2	4.5	1.2	4.5	1.2	4.4	1.2	4.6	1.2	4.4	1.1	4.1	1.1	4.1	1.0	4.1	1.0	4.0	1.0	4.0	0.9
Others	4.8	2.2	5.5	2.1	5.6	2.2	5.6	2.2	5.3	2.1	5.4	2.1	5.4	2.0	6.0	2.2	5.8	2.0	5.6	2.1	5.7	2.1	5.6	2.2	5.3	1.9	5.4	1.9

Note: Category "others" includes Defence, Public order and safety, Environment protection, Housing and community amenities, Recreation, culture and religion.

Notes: The autonomous provinces of Trento and Bolzano constitute the region of Trentino Alto Adige. Nevertheless, in our analysis we take them into consideration separately as units of analysis since they are autonomous in defining whether to adopt a CPB or not.

Fig. 1. Year of implementation of the CPB operating for the healthcare sector (period: 2003–2012).

between 2 and 8%. In addition, we explore whether the effect is heterogeneous along several dimensions. First, we look at the different sub-composition of expenditure, and we find that the effect is mostly driven by diagnostic chemical materials and hospital care. Second, it turns out that spending savings are decreasing the longer time since the adoption of a CPB. Third, the spending reduction is not affected by the co-existence of other organizational models (such as amalgamation of ASLs or hybrid systems), neither by the number of managed hospitals, nor by the presence of previously stocked products. Furthermore, we show that the spending reduction is achieved without a significant downsizing of local health services to citizens. Finally, we find that spending reduction is negligible in areas characterized by strong institutions (e.g. low level of corruption), while it is relevant in weaker ones. Taken together, these results seem to suggest that the CPB is an effective tool allowing local providers of health services to increase their efficiency, and (potentially) to prevent corruption in ASLs' purchases.

The rest of the work is structured as follows. Section 2 describes the institutional setting of the Italian system of regional CPBs. In Section 3, we describe our dataset and the empirical strategy for assessing the impact of the introduction of CPBs on ASLs' expenditure. In Section 4, we present the baseline results, while we perform a set of robustness test in Section 5. Section 6 investigates the heterogeneity of the results, Section 7 shows the impact on health outcomes, and in Section 8 we explain the mechanism of the observed reduction in public expenditure. The last Section concludes.

2. The institutional setting of the Italian system of central purchasing bodies

Despite a recent trend observed for some OECD countries towards privatization of the healthcare system (Eriksen and Wiese, 2019), the expenditure on healthcare represents one of the most significant items of public expenditure across European Union.

As shown in Table 1, since 2002 it has represented the second most relevant cost category (on average equal to 6.9% of GDP) for the 28 EU countries, right after 'Social Protection'.

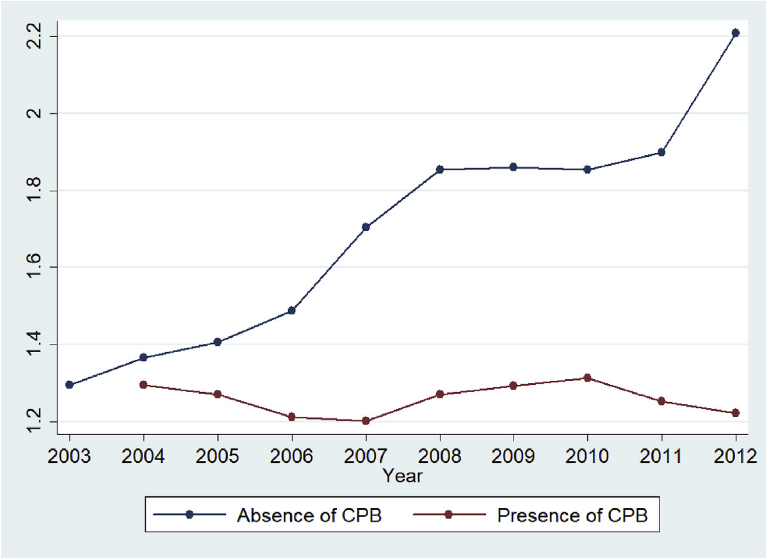
A similar picture also emerges for Italy (see Table 2), where expenditure on health is the third largest category of public spending, accounting on average for about 7% of GDP.

However, differently from EU-28 - where the expenditure is mainly concentrated at the Central Level Authority - Table 2 reveals that the Italian local authorities take the lion's part (7% of the GDP, on average during the period 2002–2015) since only a residual fraction of the health expenditures is managed by the central government.[5]

According to the procurement portal of the European Commission, every year, over 250,000 public authorities in the EU spend around 14% of GDP (approximately 2 trillion Euro per year) on the purchase of services, works and supplies.[6] In many sectors such as energy, transport, waste management, social protection and the provision of health or education services, public authorities are the

[5] In Italy and Spain, for example, sub-central governments are also heavily indebted and the central government transfer systems do not allow to curb the increase in local spending even in bailouts cases (Sorribas-Navarro, 2011).

[6] See the fact-checking of DG GROW (Internal Market, Industry, Entrepreneurship and SMEs), available at https://ec.europa.eu/growth/single-market/public-procurement_en.



Notes: The figure presents the (logs of) total per capita expenditure for ASLs operating in regions/autonomous provinces adopting a CPB (red line) and without a CPB (blue line) for the period 2003-2012.

Fig. 2. Per capita expenditure on health and non-health goods and services (total expenditure) by Italian ASLs in the presence or absence of regional CPBs.

principal buyers. As for the specific case of the health sector, the size of the public procurement varies across countries. By one estimate, the OECD (2017) indicates that health expenditures on average represents the largest share of public procurement, accounting for almost one third of public procurement spending in the OECD countries (30.1%), representing over 40% in Belgium (49%), Japan (45%), and Germany (41%). As for the specific case of Italy, the relative majority of the public procurement is completed in the healthcare sector (44%), and approximately 4.5% of Italian GDP is due to public expenditure on health completed by procurement (3.5% for OECD).

As already mentioned, EU Member States have jointly decided to formally adopt Purchasing Authorities, with the main task being of centralizing public procurement, by introducing the legal concept of 'Central Purchasing Body' (EU Directive 18/2004). In compliance with the EU directive, the Italian government introduced and defined the CPB trough the Legislative Decree n. 163/2006. As the timing of CPB adoption by regions is concerned, although the Legislative Decree n. 163/2006 forced regions to adopt their own regional CPB in 2006, many of them have adopted the CPB (or only a part of the provision of the Law) in subsequent years.[7] Through a detailed analysis of regional laws we have been able to identify when a regional CPB operating in the health sector was introduced during the period 2003–2012.[8]

In particular, looking at Fig. 1, it emerges that some regions – such as Campania, Emilia-Romagna, and Tuscany – are 'early' adopters, since they had already introduced a CPB before the 2006 Law. Yet, six regions (Calabria, Liguria, Lombardy, Piedmont, Apulia, and Sardinia) decided to adopt a CPB immediately after the 2006 Law, while other four regions adopted their CPB between 2010 and 2012 (Basilicata, Marche, Sicily, and Veneto). Finally, the remaining six regions and two autonomous provinces (Trento and Bolzano, making up the Trentino-Alto Adige Region) have introduced a regional CPB only after 2012.[9]

3. Empirical analysis

The empirical analysis is carried out using information at the local health service providers (ASLs) level, which are entitled to provide any kind of health functions (i.e. prevention, diagnostic, treatment, and rehabilitation) in each territory. Along these lines, ASLs represent the lowest level in charge of management, coordination, and provision of primary medical service for each regional area, through a network of hospitals and healthcare centers.

7 It is also true that the application of the law was furtherly amended and postponed for three times: i) in December 2011 (Decree Law 216/2011); ii) in June 2013 (Law n.71/2013) and iii) January 2015 (Financial Law, 2014).

8 Details of this analysis are available upon request.

9 The analysis of regional laws suggested that purchase centralization schemes adopted by regions before 2007 was not significantly different from the ones adopted by the others since 2007, in compliance to the 2006 Law. This result should reassure on the presence of a unique treatment across the Italian regions. Nevertheless, for the sake of robustness, we replicated our baseline estimations including interaction terms for early adopters' regions to check for any possible differences in the effects on expenditure of ASLs operating in regions adopting CPBs before 2007, finding no significant differences in the estimated impact. Details of these analyses are available upon request.

3.1. The dataset

In order to capture the impact of the introduction of CPBs on ASLs' expenditure, we built a dataset at the ASL level for the period 2003–2012. In particular, we use information resulting from a combination of different archives publicly available from the Italian Ministry of the Health and the Italian Institute of Statistic (ISTAT). Our data include the following information: (1) ASLs financial data, such as total current expenditures; (2) ASLs demographic and socioeconomic data, such as, population size, age structure, and number of families.

The main novelty of the dataset is that it contains comparable information for each item of the balance-sheets along the time span of the analysis. Indeed, the structure of the balance sheets has changed three times during the period 2003–2012: one in the period 2003–2007, one in 2008–2011 and one for 2012. Then, we have adapted all the balance items as expressed within the first two schemes to those of the last scheme (i.e. 2012). This way allows all items to be compared between ASLs over the period 2003–2012. For instance, while for the 2008–2011, and 2003–2007 schemes one might find two different items named 'Diagnostic chemicals materials' and 'Diagnostic materials, RX plates, contrast agents for RX, etc.', for 2012 scheme one can find a single line named 'Chemical products' to which are attributable the costs of the first two items.

The final sample is thus composed by 144 ASLs including 1440 observations over the period 2003–2012. Descriptive statistics on data are reported in Table A1 of the Online Appendix.

3.2. The treatment variable

Our treatment variable summarizes the public procurement structure within which the individual ASL operates. This variable describes whether the single ASL belongs to a region which adopted the CPB over the period 2003–2012, considering that ASLs belonging to the same region cannot operate in a different procurement scheme from that implied by the CPB at regional level. Consequently, our treatment variable, *CPB*, is a dummy variable taking on the value of 1 if the ASL operates in regions/autonomous provinces adopting its regional health CPB, and 0 otherwise.[10]

3.3. The dependent variables

We adopt a set of dependent variables describing the expenditure of ASLs, extrapolated from their balance-sheets. The reconciliation to a common framework led to the construction of two macro-categories: expenditure on goods, and services.

The goods category includes health goods, such as the expenditure for supplies directly used for the patient's specialist care, among which, for instance, pharmaceutical and chemical products, vaccines and surgical devices, and non-health goods, such as those products used for the ASL maintenance and for generic patient support, including, for example, alimentary products, wardrobe and cleaning materials, and stationery.

As it concerns services, the category includes the health services, such as medical advisory provided by medical specialists for primary health care and by other pharmaceutical and rehabilitation specialists who are not directly hired by the ASL and do not receive a fixed wage; and non-health services, for instance including the staff working within the laundry and the canteen, and the external training service. We also consider a measure of total expenditure, which is given by the sum of expenditure on goods and services.[11]

As a preliminary piece of evidence, it is interesting to note that the average per capita expenditure of ASL belonging to a region adopting a CPB is 330 per capita euros lower than the expenditure of ASL belonging to a region not adopting a CPB, being this difference statistically significant at 1% level.

Fig. 2 depicts the evolution of the (logs of) per capita total expenditure for ASL under the CPB regime and not under the CPB regime. What emerges is that the per capita expenditure of ASLs operating within regions not adopting a CPB is always higher than that of ASLs operating in regions where a CPB is in place. Moreover, this difference increases over time, as the regions keep purchasing through CPBs over the following years.

3.4. Control variables

Our dataset also includes a set of time-varying control variables at the ASL level. In particular, we collected demographic data from the Italian National Institute of Statistics (ISTAT) to be used within the empirical analysis: the total resident population (*population*), the share of people below 5 years old (*children*), the share of people above 65 years (*aged*), and the number of households divided by the population (*families*). These variables are meant to control for some specific health needs and hence may influence the composition of the public spending.

[10] For the sake of our analysis, when the introduction of the CPB occurred during the last quarter of a year *t*, we imputed the year *t+1* as treatment year, considering that a CPB is not ready to produce concrete effects in the first three (or less) months from its introduction by law. Reassuringly, main results do not change if we use the year of adoption to create our treatment variable.

[11] Note however that other expenditure accounts, on average, for approximately 96 per capita euros, namely less than 7% of the total expenditure (1420 per capita euros).

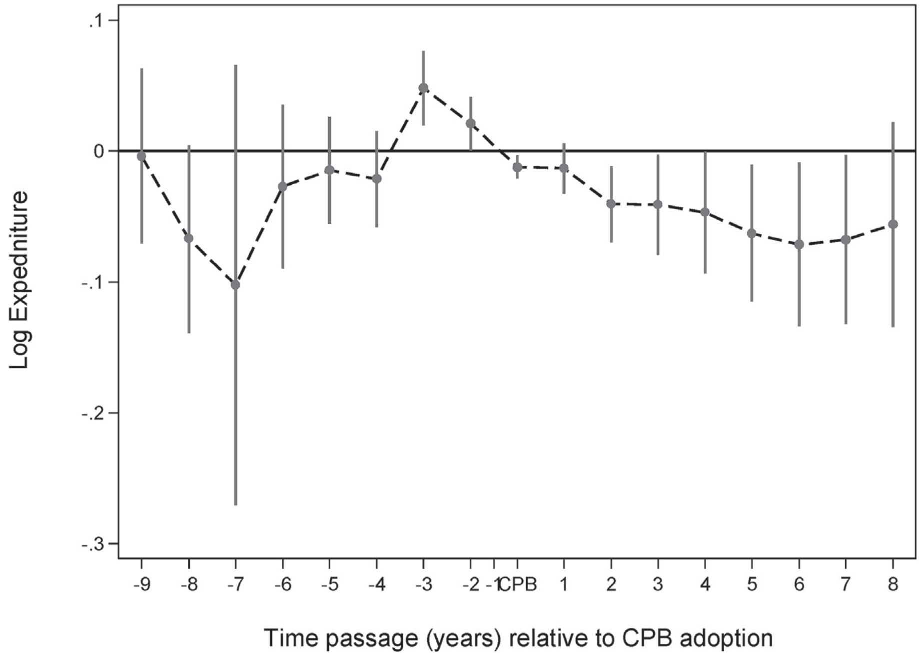


Fig. 3. Common trend assumption.

Table 3
Spending outcome baseline results.

Dep. Variable	Per-capita total expenditure (log)						
	Full sample			Matched Sample			Matching
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CPB	−0.043***	−0.049***	−0.029***	−0.052***	−0.060***	−0.020**	
	(0.013)	(0.014)	(0.007)	(0.016)	(0.018)	(0.008)	
$CPB_{2003\text{-}2012}$							−0.083***
							(0.029)
Observations	1440	1440	1440	1130	1130	1130	162
R-squared within	0.007	0.019	0.005	0.010	0.020	0.003	
# ASL	144	144	144	113	113	113	
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	
ASL FE	Yes	Yes	Yes	Yes	Yes	Yes	
Controls	No	Yes	Yes	No	Yes	Yes	
ASL specific linear trend	No	No	Yes	No	No	Yes	

Note: Period 2003–2012. CPB is a dummy variable that takes on the value one if the ASL at time *t* belongs to a region/autonomous province where exists a CPB operating for the health sector, and zero otherwise. Control variables are: population, children, aged, families. Standard errors, clustered at the ASL level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

3.5. Econometric strategy

Our objective is to identify the average effect of the CPB on the expenditures of ASLs in which the purchasing power has been centralized. Ideally, we would like to compare decisions on expenditure for ASLs that belong to regions adopting the CPB system (treated group), to the same decisions for ASLs in the counterfactual situation of not being in a region with a CPB system. This is impossible, and the best alternative would be to run a randomized control trial, which assigns participation and non-participation to the treatment status, allowing us to compare the average expenditures of the two groups. Since in our analysis we cannot make use of a controlled randomized trial, we have to turn on quasi-experimental methods to define a suitable control group that can credibly estimate the counterfactual. The main concern on the identification using these approaches is due to the unobservable characteristics that may vary between ASLs in CPB-adopting regions and not, and which might be correlated to the expenditures: a concern we try to address in what follows.

The first method that we implement is a DiD approach, as we can exploit the panel dimension of our data and thus attempting to remove the unobservable ASLs' characteristics that are fixed over time. For each year, we have ASLs in regions with CPB system (treated group) and ASLs in regions where the CPB has not been introduced yet (control group). Therefore, the goal of the analysis is to compare the difference between the control group (the unaffected ASLs) and the treatment group (the affected ASLs) before and after the introduction of the treatment, in a sort of a quasi-natural experiment.

We estimate our basic model, which considers the total amount of ASLs' expenditure as dependent variable and is expressed as follows:

$$Y_{it} = \mu_i + \tau_t + \gamma CPB_{it} + \beta x_{it} + \lambda trend_{it} + \varepsilon_{it}, \tag{1}$$

where Y_{it} is log of the per capita total expenditure in ASL i at time t; *CPB* is a dummy variable that takes on the value of one if the ASL at time t belongs to a region/autonomous province where exists a CPB operating for the healthcare sector and zero otherwise; x_{it} includes the control variables described in Section 3.4. To take account of unobserved heterogeneity across ASLs, we include a set of ASLs fixed effects, μ_i; while to control for shocks common to all ASLs in period t we add year fixed effects, τ_t. Since a key identifying assumption of the DiD approach is that the temporal development of each ASL would have been the same in the absence of any treatment, we control for any potential temporal pattern independent of the treatment status by including a complete set of ASL-specific linear time trends, $trend_{it}$. Finally, ε_{it}, is the error term, clustered at the ASL level. In this framework, γ, represents our DiD estimate of the effect of belonging to a region with CPB on health expenditure.

While the decision of adopting a CPB is ultimately a regional government choice, and hence it seems unlikely that one ASL could influence this process, there are still two potential sources of bias that might affect our estimation approach, as the CPB is not homogeneous and might vary according to some of the characteristics of the ASLs. In particular, (i) ASLs in the treatment group might be somehow different than those belonging to the control group, and (ii) the distribution of observable characteristics that affect expenditures might be different within the treatment and the control groups. We attempt to eliminate these biases in the estimations by adopting matching models. The main purpose of matching is to find a group of non-treated ASLs, who are similar to the treated in all relevant pre-treatment characteristics, **x**, the only remaining difference being that one group enters a CPB and another group does not.

In the first stage, we therefore estimate the propensity score (PS) using a discrete response model of belonging to a region adopting a CPB. In particular, we use data from the 2001 Census and run a logit regression, where the dependent variable is given by a dummy variable which takes on the value of 1 if the ASL belongs to a region/autonomous province where a CPB operating for the health sector exists, and zero otherwise during the period 2003–2012. The included control variables are: *population*, population disaggregated by age (*children* and *aged*); number of households divided by the population (*families*) and a categorical variable (*macroarea*) equal to 1 if the ASL is located in Northern Italy, equal to 2 if it is located in Centre, and equal to 3 if it is located in the South. All these variables refer to the year 2001. The results of the estimation of the propensity score model are reported in Table A2 of the Online Appenidx. Once we have obtained the propensity score, following Sianesi (2004) and Smith and Todd (2005), we adopt a trimming procedure to define the common support as the region of values of PS that have positive density within both the treatment and control groups distributions.[12] We then re-estimate Equation (1) by using information only on the observations that lie on the common support.

However, within the common support, the distribution of **x** might be different between treated and control observations, keeping the second source of bias. Therefore, we control for it by using a nonparametric DiD kernel matching estimator.[13] Following Heckman et al. (1998), we estimate

$$\gamma^{DiD} = \sum_{i\epsilon CBP} \left\{ \left[Y_{it_1} - Y_{it_0}\right] - \sum_{i\epsilon noCPB} W_{ij}\left[Y_{jt_1} - Y_{jt_0}\right] \right\} w_i \tag{2}$$

where t_0 and t_1 are time periods before and after the ASL's entrance in a CPB. Specifically, our treated group, *CPB*, is formed by ASLs that at time t_0 do not belong to a region adopting a CPB, but they will belong to a region adopting a CPB in t_1. On the contrary, the control group, *noCPB*, is composed by ASLs not belonging to regions adopting a CPB in t_0, nor in t_1. W_{ij} is the weight placed on the jth observation in constructing the counterfactual for the ith treated observation. Y is the expenditure of ASLs and w_i is the reweighting that reconstructs the outcome distribution for the treated sample. In order to have a balanced sample between the two comparison groups, we choose the years 2003 and 2012 as pre-treatment and post-treatment periods, respectively (these years coincide with the first and the last year available in our dataset). We have already mentioned that most regions adopted the CPB system in 2007 (this pattern is clear looking at Fig. 1). Hence, in the treatment group we include only ASLs belonging to regions adopting the CPB in 2007, and in the control group ASLs that never experienced a CPB system. We then perform the (ATT) matching approach as in Equation (2), by comparing expenditure between treated and control ASLs, in 2003 and in 2012.[14]

[12] We adopt the nearest-neighbours matching algorithm by using the Stata command *psmatch2* developed by Leuven and Sianesi (2003). Overall, from the matching procedure we exclude 31 ASLs from our sample.

[13] The Kernel matching approach has been performed by using the Stata command *diff* developed by Villa (2016) using the same variable that we used for detecting the common support.

[14] A further concern could be that regions with higher level of health expenditure may have accelerated the process of the adoption of the CPB, thus leading to an endogenous CPB adoption. Nevertheless, in non-reported regression results (available from the authors upon request), we have also found that the probability of adopting the CPB in a given year does not depend on the level of expenditure, nor on the level of past expenditure. This last finding, together with all the battery of approaches used, should mitigate the concern of endogeneity of the treatment. All the analyses presented in the following sections are also performed on the matched sample, when feasible, with results reported in Tables A5 through A10 of the Online Appendix.

Table 4
Spending outcome and fake implementation year.

Dep. Variable	Per-capita total expenditure (log)					
	(1)	(2)	(3)	(4)	(5)	(6)
CPB (1 year before)	−0.007	−0.020	−0.046			
	(0.015)	(0.016)	(0.029)			
CPB (2 years before)				0.019	0.006	0.003
				(0.015)	(0.013)	(0.011)
Observations	857	857	857	857	857	857
R-squared within	0.001	0.013	0.006	0.001	0.012	0.003
# ASL	144	144	144	144	144	144
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
ASLFE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	No	Yes	Yes
ASLspecific linear trend	No	No	Yes	No	No	Yes

Note: Period 2003–2012. The CPB (fake) is a dummy variable that takes on the value one if the ASL at time *t* belongs to a region/autonomous province where exists a CPB operating for the health sector two years earlier than the real year of adoption, and zero otherwisw. Observations only on the span prior the real year of the introduction of the CPB. Control variables are: population, children, aged, families. Standard errors, clustered at the ASL level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Results on the matched sample are reported in Table A5 of the Online Appendix.

4. Results

4.1. A test for the common trend assumption

The existence of a common trend is the key identifying assumption for DiD estimates to be unbiased. In the framework of this analysis, the assumption implies that in the absence of the CPB system, ASLs in adopting regions would have experienced the same trends in their expenditure as the control ones. While this is not testable, an event-study analysis can shed some light on the validity of the research design. Specifically, following Autor (2003), the interactions of the time dummies and the exposure indicator for pre-treatment periods are added to the baseline specification of Eq. (1). If the trends in the expenditure are the same, then the interactions should not be statistically significant, i.e. the DiD coefficient is not significantly different from zero in the pre-treatment period. An attractive feature of this test is that the interaction of the time dummies after the treatment (up to 8 years) with the treatment indicator is informative and can show whether the effect changes over time. In detail, the following specification is estimated as

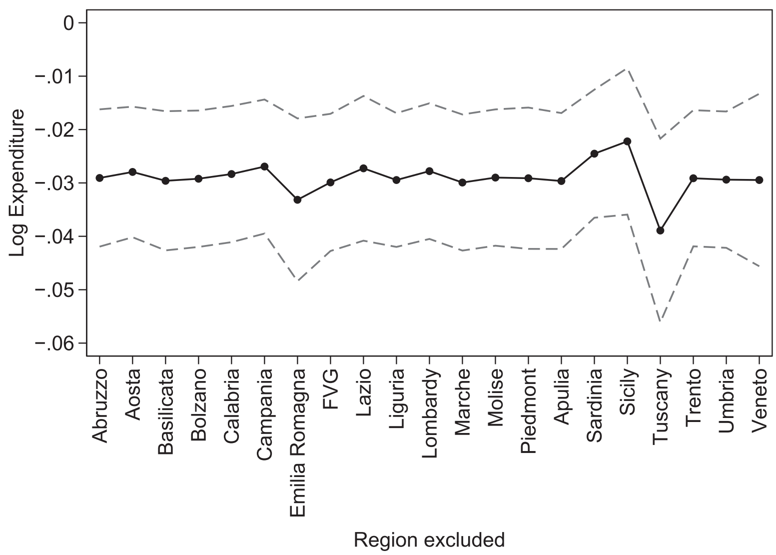


Fig. 4. Region excluded.

Table 5
Balancing test results.

Dependent Variable	Population	Children	Aged	Families
	(1)	(2)	(3)	(4)
CPB	−137.564	0.000	0.000	−0.000
	(1762.812)	(0.000)	(0.000)	(0.000)
Observations	1440	1440	1440	1440
R-squared within	0.338	0.064	0.336	0.005
# ASL	144	144	144	144
Controls	Yes	Yes	Yes	Yes
ASL FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
ASL Specific linear time trend	Yes	Yes	Yes	Yes

Note: Period 2003–2012. CPB is a dummy variable that takes on the value one if the ASL at time *t* belongs to a region/autonomous province where exists a CPB operating for the health sector, and zero otherwise. Control variables are: population, children, aged, families and exclude the dependent variable. Standard errors, clustered at the ASL level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Results on the matched sample are reported in Table A6 of the Online Appendix.

$$Y_{it} = \mu_i + \tau_t + \sum_{\pi=-9}^{-2} \gamma_\pi CPB_{i,t+\pi} + \sum_{\tau=0}^{8} \gamma_\tau CPB_{i,t+\tau} + \beta x_{it} + \varepsilon_{it}, \tag{3}$$

The omitted year is the year before the regional adoption of the CPB, which (given the staggered time of the adoption) differs by regions. This specification allows testing for the presence of parallel trends in the pre-treatment period, namely, whether the coefficients associated with the lead (γ_π, with π going from 9 years to 2 year before the adoption) are not statistically different from zero.[15] As already anticipated, this approach is convenient to understand whether the treatment effect fades, increases, or stays constant over time, depending on the estimated coefficients of the lags (γ_τ, with τ going from the year of adoption to 8 years since the adoption of the CPB).[16]

The estimates and their 90% confidence intervals are plotted in Fig. 3.[17] According to the estimates, there is no difference in the expenditure over the pre-treatment period. The only exception is given by the coefficient associated with '3 years' before the adoption, which turns out to be positive and statistically significant. This implies that the expenditure of ASLs was higher 3 years prior the introduction of the CPB as compared to 1 year prior. Nevertheless, such a result might be purely driven by the different composition of ASLs between the sample of 3 years and 1 year prior the CPB adoption, which is a typical feature of event study approaches with staggered time of implementation. Hence, to mitigate this potential concern, we focus only on regions that have adopted the CPB in 2007, so as to rely on a balanced sample over which all regions share the same number of pre-treatment (4 years) and post-treatment years (5 years), and we replicate the analysis. Results are depicted in Fig. A1 of the Online Appendix, and indicate that prior the CPB adoption there is not difference in the spending behavior during the pre-treatment period.

As for the coefficients associated to lags, they turn out to be negative and statistically significant from 2 up to 7 years after the adoption of the CPB. More precisely, following the year of the adoption, the expenditure in the treated ASLs decreases of approximately 1.3% (although it is not statistically significant, p-value = 0.253), then such an effect reduces to 4%, continuing to decrease again up to the 6th year. After 6 years, the reduction in the expenditure is found to be lower than that observed in previous years, and it becomes no longer significant during the 8th year. While the post-treatment coefficients shed light on the persistence of the CPB effect, it is worth mentioning that for some of them, 7 and 8 years after the CPB introduction, the sample of treated ASLs is too small to identify a significant effect. To see this, consider that after 7 years the effect can be identified only for ASLs belonging to Emilia-Romagna and Tuscany, namely for those located in regions that adopted the CPB system in 2005; in a similar vein the effect after 8 years is captured only by ASLs in Emilia-Romagna.[18]

Overall, these results seem to validate the research design, as there is no evidence against the presence of a common trend between treated and control units.

4.2. Baseline results

The results of the first set of three regressions estimated using as dependent variable the (log of) per capita total expenditure are provided in Table 3. In particular, in column 1, we estimate Equation (1) in the full sample, including only ASL- and year-fixed effects. We find that the introduction of a CPB is associated to a reduction in ASLs total expenditures by 4.3%, and the effect is significant at 1 percent.

[15] It is worth noting that the last year of adoption of the CPB has been in 2012. Therefore, since the datset begins in 2003, the maximum number of leads is 9, while the minimum is 2 because of the omitted year.

[16] In this case, the maximum number of lag that can be estimated is 8, as the year of the first adoption of CPB is 2004.

[17] Point estimates are reported in Table A3 of the Online Appendix.

[18] Campania adopted the CPB system in the last quarter of 2005, therefore for the ASL located in this region the treatment status has been set equal to one from 2006 onwards.

Table 6
Inventory outcome baseline results.

Dep. Variable	Per-capita inventory		
	(1)	(2)	(3)
CPB	0.002 (0.002)	0.002 (0.002)	0.003 (0.002)
Observations	1440	1440	1440
R-squared within	0.008	0.010	0.015
# ASL	144	144	144
Year FE	Yes	Yes	Yes
ASL FE	Yes	Yes	Yes
Controls	No	Yes	Yes
ASL specific linear trend	No	No	Yes

Note: Period 2003–2012. CPB is a dummy variable that takes on the value one if the ASL at time t belongs to a region/autonomous province where exists a CPB operating for the health sector, and zero otherwise. Control variables are: population, children, aged, families. Standard errors, clustered at the ASL level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Results on the matched sample are reported in Table A7 of the Online Appendix.

Table 7
Spending outcome different categories.

Dep. Variable	Goods	Services	Goods			Health services primary care		
			Pharmaceutical products	Diagnostic chemical materials	Surgical and medical products	Primary care	Hospital care	Specialistic care
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CPB	−0.021* (0.013)	−0.030*** (0.007)	−0.040* (0.021)	−0.266** (0.124)	−0.116* (0.068)	−0.014 (0.011)	−0.101** (0.045)	−0.027* (0.015)
Observations	1440	1440	1440	1383	1437	1440	1404	1440
R-squared within	0.031	0.004	0.010	0.033	0.013	0.011	0.017	0.004
# ASL	144	144	144	144	144	144	144	144
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ASL FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ASL specific linear trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Period 2003–2012. CPB is a dummy variable that takes on the value one if the ASL at time *t* belongs to a region/autonomous province where exists a CPB operating for the health sector, and zero otherwise. Control variables are: population, children, aged, families. Standard errors, clustered at the ASL level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Results on the matched sample are reported in Table A8 of the Online Appendix.

One issue is that there might be some ASL characteristics varying across time and space, potentially correlated to the central purchasing body and health expenditure. Therefore, we estimate our DiD model controlling for a series of demographic factors described in Section 3.4. The inclusion of the control variables slightly increases the magnitude of the treatment effect, as the estimated coefficient of CPB turns out to be equal to −4.9% and statistically significant at 1% (col. 2). Finally, it might be the case that the temporal development of each ASL would not have been the same in the absence of any treatment. Hence, we include a set of ASL-specific time trends with the main aim being to control for any potential differential temporal developments independent of the treatment. The inclusion of the linear specific time trend slightly changes the magnitude of the treatment effect. In fact, looking at column 3, we notice that the coefficient of CPB is still negative (−2.9%) and significant at 1%, however it drops by 2 percentage points, thus suggesting that is important to control for these different temporal developments of each ASL.

The estimates in columns 4, 5 and 6 of Table 3 are obtained by restricting the analysis on the subsample of matched municipalities, and all confirm our previous findings, with the effect of CPB being slightly larger than that found for the full sample. This approach should control for the bias arising when municipalities in the treatment group differ from those included in the control group. Finally, in column 7 of Table 3 we report the results of the nonparametric DiD kernel matching estimation. This methodology should take into account of possible differences, between treatment and control groups, in the distribution of observable characteristics that influence expenditures. We again find similar results to the previous estimates: being in a region with a CPB system reduces the ASL's expenditure by around 8% and the effect is significant at 1%.[19]

[19] Results are fully confirmed with errors clustered at the regional level, as reported in Table A4 of the Online Appendix.

Table 8
Heterogeneous effects.

Dep. Variable	Per-capita total expenditure (log)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CPB	−0.045***	−0.049***	−0.032***	−0.042***	−0.051***	−0.037***	−0.057***	−0.059***	−0.028***
	(0.013)	(0.014)	(0.007)	(0.014)	(0.016)	(0.009)	(0.019)	(0.020)	(0.010)
CPB × amalgamation	0.078*	0.076*	0.050						
	(0.046)	(0.046)	(0.033)						
CPB × hybrid				−0.012	0.020	0.057*			
				(0.017)	(0.022)	(0.029)			
CPB × hospitals							0.001	0.001	−0.000
							(0.001)	(0.001)	(0.001)
amalgamation	−0.109***	−0.138***	−0.032						
	(0.035)	(0.038)	(0.024)						
hybrid				−0.003	−0.011	−0.063			
				(0.025)	(0.025)	(0.039)			
Observations	1440	1440	1440	1440	1440	1440	1440	1440	1440
R-squared within	0.015	0.033	0.006	0.008	0.012	0.006	0.008	0.012	0.005
# ASL	144	144	144	144	144	144	144	144	144
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ASL FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
ASL specific linear trend	No	No	Yes	No	No	Yes	No	No	Yes

Note: Period 2003–2012. CPB is a dummy variable that takes on the value one if the ASL at time *t* belongs to a region/autonomous province where exists a CPB operating for the health sector, and zero otherwise. Control variables are: population, children, aged, families. Standard errors, clustered at the ASL level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Results on the matched sample are reported in Table A9 of the Online Appendix.

5. Robustness checks

In this section, the validity of the previous results is confirmed by a battery of robustness checks that are intended to address possible issues related to the research design, and could bias the baseline estimates. First, the classical placebo test is performed, then we move to a falsification exercise to prove that the estimated effects does not ensue from other regional shocks, and lastly, after controlling for ASL- and year-fixed effects, we test for the potential presence of remaining sources of bias by performing balancing regressions and by considering other confounding factors.

5.1. *Fake treatment adoption*

A common way to conduct a placebo test in the context of DiD analysis is to focus on the span prior to the shock, that is, to simulate what would have happened to the ASLs' expenditure if a fake year of the adoption was used. Specifically, we replicate the main analysis by assuming that the CPB adoption occurred 1 and 2 year(s) earlier than the true data. Were the coefficient associated to CPB negative and significant, it would suggest that even before the true year of the introduction of the CPB, future treated ASL had already a different path of expenditure, thus casting doubt on the validity of the previous results.

Reassuringly, the effect of the placebo exercise does not lead to any effect on expenditure as the γ coefficient turns out to be indistinguishable from zero in the specification that do not include control (Table 4, col. 1 and 4), in the specification where controls are included (Table 4, col. 2 and 5) and in the specification where ASLs specific trend are factored-in (Table 4, col. 3 and 6).[20]

5.2. *Region outliers*

It is also important to test whether our main findings are sensitive to the exclusion of a single region or autonomous province, given their relatively low number in our sample. For this reason, we have estimated Equation (1), by dropping one region/autonomous province at a time. The result of the estimated coefficient, γ, and its 95% confidence interval, are shown in Fig. 4, indicating that results are very similar to that obtained in our baseline specification. Hence, it can be concluded that our main results are not driven by a particular region, nor by a specific autonomous province.

[20] It is worth noting that since we are exploiting the staggered time of the CPB adoption the use of earlier years than 1 or 2 to run our placebo exercise might lead to bias results. To see this, consider that using 3 or 4 years earlier for creating a fake year of CPB adoption would imply to identify the effect only for those regions adopting the CPB (at least) starting from 2008, namely for only 4 regions. On the contrary, the use of 1 and/or 2 years earlier implies that only ASLs located in Emilia-Romagna (for both 1 and 2 years) and Tuscany (only for 2 years prior the real adoption) do not contribute to the identification of the (fake) effect.

5.3. Balancing test

While in the baseline estimates we control for time-invariant unobserved determinants of ASL expenditure by including ASL-fixed effects, there still might potentially be some remaining sources of bias due to unobserved confounders. The usual way to overcome this issue is to add variables as controls on the right-hand side of the regression. In this case, if the presence of unobserved effects was relevant, the coefficient of interest would be sensitive to the inclusion of these controls. As the comparison of the estimates in Columns (1 and 4) and (2 and 5) of Table 3 shows, adding controls to the baseline specification hardly changes any of the results. However, these demographic, socio-economic variables might be poorly measured proxies of the confounders. As recently shown by Pei et al. (2018), a more sensitive test consists of including individual controls as dependent variables on the left-hand side of the regression equation. Table 5 shows that of these balancing regressions for various demographic and socio-economic controls, none yields significant effects. These results help to rule out the possibility that a correlation between the CPB treatment variable and other time-varying characteristics of ASLs is driving the results.

5.4. Stocks of products

A remaining concern might be related to the amount of stocks of the materials and medicines used by hospitals to treat diseases, or contracts on services or purchases that cannot be cancelled the moment a CPB is introduced. Were it the case, the reduction of expenditure observed could be simply due to the use of the stocks of these materials, rather than the introduction of the CPB. It is therefore important to verify that our results are not driven by changes in the amount of stocks. To deal with this issue, we have collected information on inventories from the ASLs' balance sheet, then we have estimated Equation (1) using per-capita values of inventories as the dependent variable. If the change in the stock of materials drives our results, we would expect the coefficient of CPB to be negative and statistically significant.

The results of this analysis are shown in Table 6 and reassuringly indicate that changes in the stock of materials is not a source of concerns, as the coefficient associated with CPB is not statistically significant in the specification that does not include control (Table 6, col. 1), in the specification where controls are included (Table 6, col. 2) and in the specification where ASLs specific trend are factored-in (Table 6, col. 3).

To sum up, the analyses carried out in this section have strengthened the evidence of a negative relationship between the introduction of the CPB system and the expenditure of ASLs. In addition, the results indicate that it is very likely that such an effect is due to the shock caused by the introduction of the centralized purchasing system, as no other plausible explanations that clearly hold as an argument against a causal interpretation of this relationship are found.

6. Heterogeneous effects

To investigate whether there is evidence of heterogeneous effects, we analyze how the effect of CPB varies along several dimensions.

6.1. Spending categories

To begin with, we estimate Equation (1) using, as dependent variables, the per capita (log) health expenditure divided by categories: goods and services, and in their relative subcomponents. In particular, as for goods we gather information on *i)* pharmaceutical products; *ii)* diagnostic chemical materials, and *iii)* surgical and medical products. These components, together, account for more than 80% of the total amount of goods purchased by the ASLs. In terms of services, we collect data on *i)* health services for primary care, *ii)* health services for hospital care and *iii)* health services for specialist care which represent approximately 60% of the total amount of spending devoted to services.

In this way, it is possible to detect whether health expenditure savings can be primarily obtained by a reduction of a specific component. Results of this analysis are reported in Table 7, where in each specification we include control variables, ASLs- and year-fixed effects, and the ASL-specific linear time trend. According to the results, all categories but health services for primary care yields significant and negative effects at the conventional level. More in details, it turns out that health savings are due to both categories of expenditure (goods and services), being the reduction in expenditure on health services slightly larger than that observed for goods. Indeed, the coefficient of CPB is negative (−3%) and 1% significant for the case of health services, while it is negative (−2%) and statistically significant at 10% for the case of health goods. Moreover, it is worth noting that among goods the reduction in expenditure seems to be triggered by diagnostic chemical materials, as the coefficient associated to CPB is negative (−26.6%), significant at 5% (col. 4), and much larger than the one found for goods. As far as services are concerned, the reduction in expenditure is driven by the component related to hospital care. Indeed, the coefficient of CPB is negative (−10%), 10% significant (col. 7) and 5 times greater as the one estimated for services.[21]

[21] As shown in Table A8 of the Online Appendix, similar results are obtained when estimating these models on the matched sample, with expenditure on diagnostic chemical materials and hospital care services leading the overall effect.

Table 9
Outcome effects (mortality and discharge rates).

Dep. Variable	Aids	Cancer	Diabetes	Circulatory Syst	Respiratory Syst	Skin	Mental
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Mortality rate (log)							
CPB	−0.010	0.006	0.008	0.007	0.004	0.051	−0.033
	(0.077)	(0.006)	(0.015)	(0.005)	(0.013)	(0.068)	(0.022)
Observations	932	1014	1014	1014	1014	989	1014
R-squared within	0.002	0.003	0.002	0.011	0.012	0.009	0.013
# Provinces	103	103	103	103	103	103	103
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province specific linear trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Discharge rate (log)							
CPB	−0.044	−0.011	0.032	0.010	0.008	−0.022	−0.015
	(0.036)	(0.007)	(0.032)	(0.008)	(0.011)	(0.016)	(0.018)
Observations	1016	1018	1018	1018	1018	1018	819
R-squared within	0.022	0.410	0.0901	0.378	0.319	0.160	0.195
# Provinces	103	103	103	103	103	103	103
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province specific linear trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Period 2003–2012. CPB is a dummy variable that takes on the value one if the ASL at time t belongs to a region/autonomous province where a CPB operating in the health sector exists, and zero otherwise. The mortality rate variable refers to the overall mortality rate related to the specific disease in a given province. Standard errors, clustered at the province level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

6.2. *Third factors: merger and hybrid ASLs*

So far, we have shown that the introduction of CPBs led to a reduction of expenditure on total ASLs' expenditure, suggesting that centralizing purchases can be considered as a useful tool for larger efficiencies in the healthcare sector. However, the centralization of purchases is not the only way to achieve savings on public expenditure in health, nor necessarily the most efficient one, and further efficiencies may be achieved thanks to other possible third factors. For instance, the merger of ASLs decided by the regions should lead to spending reduction due to a 'natural' contraction of fixed unsinkable costs. Hence, in order to test whether the amalgamation of two or more ASLs has triggered a larger or smaller amount of saving, we build a new variable, $amalgamation_{it}$, which takes on the value of one if the ASL has been merged along the time-span of the analysis, and zero otherwise. This variable is then interacted with CPB. It is important to note that in this specification framework, while the coefficient of CPB allows the impact of the introduction of central purchasing bodies to be isolated from any kind of aggregation effects, i.e. it estimates the impact of a CPB for ASLs where no merger has taken place, its interaction with the amalgamation indicator accounts for or the differential effect of having a CPB system for amalgamated ASLs, and the coefficient associated with $amalgamation_{it}$ captures the impact of the merger for ASLs not having a CPB system.[22] Results are shown in Table 8, and it emerges that the coefficient of CPB is negative, statistically significant at 1% level in all specifications and very close to the ones found in the baseline specification. Turning now to the effect of the merger for ASLs not belonging to regions with a CPB system, the coefficient of $amalgamation_{it}$ is found to be negative and statistically significant at 1% level in the case of the model including only ASLs- and yearly-fixed effects (−0.109, col. 1) and when controls are included (−0.138, col. 2), but it is indistinguishable from zero when ASLs linear specific time trends are introduced. As for the interaction term, $CPB \times amalgamation_{it}$, the coefficient is positive in all the specifications, but it is only marginally significant at the 10% when ASLs linear specific time trends are excluded (col. 1 and 2), thus revealing that the introduction of CPB and the merger of ASLs are likely to be substitute in their effect.

Furthermore, some ASLs may operate within a 'hybrid' system, which is neither fully centralized (CPB-based) nor decentralized (ASL-based). Specifically, ASLs may agree to group together and nominate one representative which can procure for all the other entities belonging to the group (Baldi, 2014). Therefore, to consider this further source of heterogeneity we proxy the presence of hybrid system with the introduction of 'Area Vasta' (AV, Wide Area) in some of the Italian regional healthcare systems. Indeed, AVs can undertake procurement activities on behalf of the participating ASLs. Moreover, since AVs are constituted at a sub-regional level (i.e. provinces), ASLs belonging to AVs implicitly follow a hybrid procurement system. It follows that we build a new variable, $hybrid_{it}$, which takes on the value of one if the ASL operates within a hybrid system (i.e. participates to an AV), and zero otherwise. This variable is then interacted with CPB. As in the previous specification, while the coefficient of CPB allows the impact of the introduction of central purchasing bodies to be isolated from any sort of hybrid effects, thus picking up the impact only for ASLs not belonging to an AV, its

[22] It is worth mentioning that 25 ASLs (approximately 17% of the total) were merged and among these 21 experienced also a CPB system.

Table 10
Quality of institutions and expenditure savings.

Dep. Variable	Per-capita total expenditure (log)				
	(1)	(2)	(3)	(4)	(5)
CPB	−0.055***	−0.053***	−0.047***	−0.044***	−0.039***
	(0.013)	(0.013)	(0.011)	(0.010)	(0.010)
CPB × Control of Corruption	0.046***				
	(0.016)				
CPB × Regulatory Quality		0.046***			
		(0.017)			
CPB × Rule of Law			0.034**		
			(0.014)		
CPB × Government Effectiveness				0.029**	
				(0.013)	
CPB × Voice & Accountability					0.020
					(0.015)
Observations	1440	1440	1440	1440	1440
R-squared within	0.007	0.007	0.006	0.006	0.005
# ASL	144	144	144	144	144
Year FE	Yes	Yes	Yes	Yes	Yes
ASL FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
ASL specific linear trend	Yes	Yes	Yes	Yes	Yes

Note: Period 2003–2012. CPB is a dummy variable that takes on the value one if the ASL at time t belongs to a region/autonomous province where a CPB operating in the health sector exists, and zero otherwise. Standard errors, clustered at the province level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Results on the matched sample are reported in Table A10 of the Online Appendix.

interaction with the hybrid indicator accounts for or the differential effect of having a CPB system for hybrid ASLs, and the coefficient associated with $hybrid_{it}$ captures the impact of ASLs belonging to the AV not having a CPB system.[23] Results of this analysis are shown in Table 8 (col. 4 – col. 6), and we find that the coefficient of CPB is negative, statistically significant at 1% level in all specifications and very close to the ones found in the baseline specification. Turning now to the hybrid effect, it emerges that the coefficient of $hybrid_{it}$ is negative, but it is indistinguishable from zero in all specifications. As for the interaction term, $CPB \times hybrid_{it}$, the coefficient is positive, albeit marginally significant at the 10%, only when ASLs linear specific time trends are included (col. 6). Also in this case substitute effects on health expenditure are detected.

What these results simply reveal is the presence of a negative and robust impact of the CPB introduction on ASLs expenditure also in the presence of third effects. On the contrary, if anything, the weak evidence found for the interaction term seems to indicate that the coexistence of amalgamated/hybrid systems and a central purchasing one does not bring about savings as one single ASL could benefit were only the CPB system in place. It is likely in fact that the presence of multiple systems generates an increase of coordination costs which may offset the benefits of having one single organizational/procurement model.

6.3. Number of hospitals

Another source of heterogeneity that may affect expenditure savings is the number of hospitals and hospital facilities managed within a given ASL. The intuition is simple, being in a CPB system formed by ASLs with a large number of hospitals may be more demanding in terms of organization costs and coordination than being in a CPB system with a relatively small number of hospitals. In other terms, a centralized procurement for two hospitals might have very different effects as compared to a centralized procurement for ten. To see whether this is the case, we control for the number of hospitals in a given ASL, by defining a new variable, $hospitals_i$, which varies only between ASLs, ranging from a minimum of 2 to a maximum of 45. We interact this variable with CPB and we re-estimate the baseline specification including this new additional term ($CPB \times hospitals_t$).[24]

In columns 7, 8 and 9 of Table 8, we report these estimates. While the coefficient associated with CPB is always negative and statistically significant at 1% in all specifications, its interaction with the number of hospitals turns out to be close to zero and not statistically significant, thus suggesting that expenditure savings seem not to be driven by the size of the ASLs, proxied by the number of managed hospitals.

[23] It is worth noting that 24 ASLs (approximately 17% of the total) belong to a hybrid system and among these 11 also operated within a CPB system after 2005, and one worked within a CPB system in 2012.

[24] The number of hospitals by ASLs has been collected for the year 2015, the earliest date for which information were available. While the best solution would have been that of relying on data over the period of the analysis, it is very likely that the number of hospitals in 2012 (the last year of observations in our analysis) was quite similar to that of 2015.

7. Health outcomes

One possible drawback of the analysis conducted so far concerns the level of health services locally provided by ASLs. Indeed, expenditure savings observed for ASLs might simply be the consequence of a reduction of service received by the local population. Were it the case, this result would change the interpretation of our previous conclusions, as the cost reduction would not be the derived from economies of scale, increase in bargaining power and decrease in transaction costs, but, instead, it would simply be due to a more general shrinking of the welfare level provided to citizens.

To verify whether the reduction of expenditure after the introduction of a CPB led to a decrease in the provision of health services, we would need to rely on exact measures of the quantity or quality of those services. Unfortunately, these exact measures are hardly to be collected and one possible way to overcome this limitation is that of considering some variables that can proxy the level of health outcome of the population, while capturing the level of quality care/service.

Hence, we first use the hospital discharge rate of seven categories of diseases: AIDS, Cancer, Diabetes, Circulatory System Diseases, Respiratory System Diseases, Skin Diseases, and Mental Diseases. However, one might argue that, in the extreme case, if hospital discharge rates include also dead patients being discharged, discharge rates can remain unchanged – especially if an increasing number of dead patients are being discharged – thus leading to a poor proxy of quality in the health sector. Therefore, we complement the analysis by also considering the overall provincial mortality rate associated to the same seven diseases. Were both hospital discharge and mortality rate unaffected, it would provide further evidence in favor of the CPB as a system that allows efficiency gains to be achieved in the healthcare sector.

Since this data is available from ISTAT at the province (NUTS 3) level, we adopted provinces as a proxy for ASLs. We are confident in using provinces as a proxy for ASLs, since the ASL perimeter of competence is typically consistent with the provinces one.[25] Indeed, a single ASL exclusively operates within a single province in more than 75% of occurrences. In these cases, we were able to directly use the province as the best proxy for the ASL. Conversely, the remaining 25% is mainly due to provinces in which two or more ASLs concurrently operate. This is typically the case of large cities such as Rome, Turin, and Milan, as well as of polycentric provinces such as Forlì-Cesena. In these occurrences, we built a sort of 'macro-ASL' as a sum of two or more ASLs in consistency with the province area. Finally, in only two cases all the provinces of a region are served by a single ASL (in the case of smaller regions, i.e. Molise and Marche). To avoid inconsistencies in the dataset, for these two occurrences we adopted data at the regional (NUTS 2) level.[26]

Turning now to the results, estimates indicate that when using the mortality rate as the dependent variable (Panel A – Table 9, Col. 1 through 7), none of the variables used as proxies of healthcare outcomes has been significantly affected by the introduction of CPB, with the effect being estimated around zero for some of the outcome variables. In a similar vein, when the hospital discharge rate is used as the dependent variable (Panel B – Table 9, Col. 1 through 7), results remain unaffected by the introduction of the CPB, as coefficients are not statistically significant and around zero for most of the outcome variables.

Although the introduction of CPBs is aimed at achieving financial efficiency and cost reduction through the centralization of purchase, taken together these results provide evidence that efficiency in the healthcare sector has been achieved without significantly affecting the level of health services for the population.

8. Explaining the mechanism

We now investigate why the presence of CPB led to a decrease in total expenditure. A seemingly obvious candidate is the quality of institutions, as spending in ASL might be simply inflated by the presence of a poor-quality environment. In the absence of a Central Purchasing Body, each ASL has the power to set its own framework agreements for the purchasing of goods and services. It follows that ASLs operating in corrupted area are more likely to be affected by local crime infiltration (Prud'homme, 1995; Tanzi, 1996) which, in turns, could lead to (inefficient) tenders with favorable prices and thus translated to higher expenditures. On the contrary, a centralized system is less prone to be affected by the conditions of operating in areas plagued by corruption or endowed with low levels of institutional quality (Baldi and Vannoni, 2017). In other terms, the presence of a regional centralized purchasing system should alleviate these crime-infiltration linkages occurring at the ASL level, and thus it should bring to a more efficient system. Were it the case, as a consequence of the CPB adoption, we would observe a more marked reduction in ASLs' expenditure located in areas characterized by weak political institutions compared to the others.

Hence, we collect data on the Institutional Quality Index, developed by Nifo and Vecchione (2014) for Italian local governments, and based on the World Governance Indicators (WGI), to test for this assumption. While these data are available at the province level, they can perfectly be linked to our ASL information since the boundaries of ASL very often coincide with that of the Italian provinces. More in detail, we rely on the following indexes: *i)* control of corruption, *ii)* regulatory quality, *iii)* rule of law, *iv)* government effectiveness and *v)* voice and accountability. For each of them we use the median value to divide ASLs in those belonging to weak quality institutions – namely those with a value below the median – and those above, and then we interact this indicator with our CPB treatment variable in a model that takes the following form:

$$Y_{it} = \mu_i + \tau_t + CPB_{it} * (\gamma + \alpha * Quality\ index_i) + \beta x_{it} + \lambda trend_{it} + \varepsilon_{it}, \tag{4}$$

[25] See Table A11 in the Online Appendix for details on the Correspondence between ASLs and Italian provinces.

[26] We also checked that common trend assumption and baseline results hold also within this data setting. Estimations are available upon request.

where *quality index*$_i$ is a dummy variable equal to one if the indicator used as a proxy of the quality of institutions is above the median value and zero otherwise.[27] It follows that the coefficient associated to CPB, γ, now measures the effect of the CPB on the (log) of total per-capita expenditure in ASLs with weak political institutions, while the coefficient associated to the interaction term, α, captures the differential effect of the CPB for ALS belonging to areas characterized by high political institutions.

Results of this analysis are reported in Table 10 and indicate that the quality of institution plays a key role in explaining our findings. In particular, following col. 1, it turns out that the presence of CPB is associated to a reduction in total per-capita expenditure only in area plagued by a low level of control for corruption (−5%; statistically significant at 1%), and this effect is statistically different from the one observed for ASLs belonging to areas characterized by a high level of control for corruption, as the coefficient on the interaction term is found to be positive (4%) and statistically significant at 1%. In practice, for the ASLs located in better institutional areas the introduction of the CPB brings about no effect as the combined coefficients of $\gamma + \alpha$ lead to an estimate ($-0.01 = -0.05 + 0.04$) that is not distinguishable from zero (p-value = 0.250). The same results hold if other measures of quality of institutions are used (see Col. 2–5).

Overall, we find that in areas characterized by weak political institutions, where ASLs are likely to be more exposed to crime infiltration, the introduction of a centralized purchasing system leads to a reduction of expenditure, thereby reinforcing the evidence that centralized systems might be better equipped to pursue efficiency goals in areas plagued by corruption or with low levels of institutional quality. This path of results is also consistent with the literature supporting fiscal centralization against fiscal decentralization, as the proximity of local officials to local firms enhances the probability of ending in collusive activities (Prud'homme, 1995; Tanzi, 1996).[28]

9. Conclusions

According to OECD (2011), the elements that characterize the action of the central purchasers are related to three main stylized facts: 'large procurement volumes generate better prices', 'transaction costs are reduced' and 'other benefits of a significant nature occur', which cannot be directly expressed in economic terms, mainly including need of standardization and professionalization within Public Administration, and increase of simplicity in the acquisition of goods and services. These principles are also the basis of the outcome of European political debate that led to the introduction in 2004 of the concept of purchase centralization among all member States with the EU Directive n.18. As a member state, Italy adopted the Directive introducing its contents in 2006 within the Legislative Decree n.164, providing for the mandatory establishment of Central Purchasing Bodies at a regional level. The main goal of this work was to verify that the introduction of a CPB - a subject in charge of purchasing goods and services at the regional level - has created an advantage in terms of reduction of local health service providers' (ASLs) expenditure, at least with the same level of service provided to citizens. In other terms, we wanted to assess whether the purchase centralization of goods and services used by ASLs has made local healthcare procurement more efficient.

The realization of this study was based on two preliminary analyses. First, referring to legislation from time to time introduced at the regional level, we promptly represented when each region/autonomous province has introduced a CPB within its system, in order to supply the ASLs of its territory. This legal analysis allowed us to produce a treatment variable to identify those regions - and consequently ASLs - which were affected by the introduction of a CPB operating in the healthcare sector over the period 2003–2012. Second, we built the panel for the analysis in three steps: first, by collecting official financial data for the ASLs for the 19 Italian regions and 2 autonomous provinces, then reconciling the single balance-sheets lines to a common framework and aggregating them into two categories (goods, and services), finally selecting a unique identifier for the whole period (considering aggregation of ASLs during the period of analysis). We employed a DiD approach combined with matching models, and we found that costs related to the purchase of goods and services by ASLs were actually reduced by the introduction of CPBs, in a range that goes from −2% to −8% of total expenditure, depending on the used specification. Moreover, the reduction in expenditure is achieved without a significant downsizing of local health services to citizens. Furthermore, we showed that the saving effect is primarily due to a decrease in costs of diagnostic chemical materials, and services in the area of hospital care. In addition, the reduction in total expenditure decreases the longer the time since the adoption of a CPB, and is further confirmed also in the presence of different thirds effects (i.e. amalgamation of ASLs, existence of a hybrid procurement system, the number of hospitals managed within the ASL, and the presence of previously stocked products). Finally, we showed that the introduction of a centralized system is associated to a reduction of total expenditure on ASLs belonging in areas characterized by weak political institutions. In contrast, there are no benefits of a centralized system in areas with high quality of institutions, or where the corruption is low.

But how and to what extent these results can be generalized? In 2013, the European Anti-Fraud Office (OLAF), on behalf of the European Commission, conducted a comprehensive study across EU member states on identifying and reducing the costs of corruption in public procurement, with the main aim of providing information, methodologies and tools for the European Commission to implement EU anti-corruption policies. Based on the findings of the study, it turns out that one of the most important recommendations to all EU and national authorities responsible for public procurement, and prevention, detection and investigation of corruption was to rely more on centralized public procurement system, as it represents an effective way to fight against corruption in public procurement, thus resulting in cost savings (European Commission, *Identifying and Reducing Corruption in Public Procurement in the EU*, p. 18, 2013). Along

[27] Note that the quality index is measured in 2004, the first year for which data are available, and it does not vary over time.

[28] This result also reconciles with the literature on fiscal federalism stating that the benefit of decentralization in terms of higher accountability can be offset, or even reversed if the degree of press freedom is low (Lessmann and Markwardt, 2009), and when the political and bureaucracy competences – closely related to the quality of institution – are poor (Albornotz and Cabrales, 2013).

these lines, the Department for International Development, in its note on the status of the corruption in the health sector in 2010, vividly stated that since the health service delivery is often decentralized, it is «difficult to standardize and monitor service provision and procurement» (Department for International Development, *Addressing corruption in the health sector*, p.6, 2010). Nevertheless, there might still be potential gains of corruption for individuals performing the purchasing task when there are larger contracts are at stake.

Declaration of competing interest

The authors declare that he has no relevant or material financial interests that relate to the research described in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejpoleco.2020.101963.

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