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DISTORTION BY AUDIT: EVIDENCE FROM PUBLIC PROCUREMENT

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ABSTRACT

Public sector audits are a key element of state capacity. However, we find that they can create unintended distortions. Regression discontinuity analysis from Chile shows that audits lowered the use of competitive auctions for public procurement, reduced supplier competition, and increased the likelihood of incumbent, small, and local firms winning contracts. We also find suggestive evidence of a price increase. Looking inside the black box of the audit process reveals that relative to comparable direct contracts, auctions underwent more than twice as many checks and led to twice as many detected infractions. These findings show that standard audit protocols can mechanically discourage the use of more regulated, complex and transparent procedures that involve more auditable steps.

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1 Introduction

No state can successfully execute its functions, ranging from infrastructure provision to regulation and redistribution, without a reliable way of monitoring rule compliance through audits. While the economics literature usually considers audits as neutral information collection tools (e.g. Becker, 1968), we show that audits can not only be ineffective, but can actually backfire by creating (unintended) distortions even in a low-corruption, high-capacity setting. In particular, looking into the black box of the audit process reveals that commonly used mechanical "auditing by checklist" approaches may inadvertently discourage the use of more regulated, complex and transparent procedures and ultimately reduce the transparency and competitiveness of the process that audits were designed to improve.

We empirically analyze this issue in public procurement: an important but understudied area of public finance and a key focus of government auditing. We present three main empirical findings. First, using regression discontinuity analysis, we find that audits trigger a subsequent shift away from transparent auctions towards less competitive direct contracting. This distortion goes against the goals of the national public procurement regulation the audits are intended to enforce. Second, this leads to a significant reduction in supplier competition and, consistent with a process that favors insiders, subsequent contracts are more likely to be awarded to incumbent, small, and local firms. We also find suggestive evidence of a price increase. Third, we collect additional data on the audit process itself and find that relative to comparable direct contracts, auctions mechanically undergo more than twice as many checks and lead to twice as many detected infractions, creating a distortionary incentive.

Such distortions in public procurement can have important impacts, given the large role government plays in many markets. Public procurement includes most public spending other than salaries and transfers and represents a large share of the economy (about 13% of GDP and 29% of total general government expenditures in the OECD (OECD, 2016a)). The government is the largest buyer in most countries and public procurement contracts

can have significant impacts on supplier firms (e.g. Ferraz et al., 2016; Barrot and Nanda, 2018; Carrillo et al., 2019; Hjort et al., 2019). Free and fair competition for government contracts is therefore of great importance not only for the quality and cost of government purchases, but also to create a level playing field for all firms. In contrast to private sector procurement, where firms are free to choose their suppliers as they wish, governments have an obligation to provide equal access and not to discriminate in their choice of suppliers. Privileging incumbents and connected firms creates barriers to entry for new firms, with potential detrimental effects on innovation and economic growth. For these reasons, many governments and international organizations promote the use of competitive and transparent public auctions over direct contracting procedures (e.g. OECD, 2015; World Bank, 2016).

Measuring impacts of audits on subsequent behavior is notoriously difficult since entities selected for an audit are usually different from others in many observable and unobservable ways. To overcome this challenge, we exploit cutoffs in the audit selection process of the Chilean Comptroller Agency. This allows us to employ a fuzzy regression discontinuity design (RDD) using administrative data on the universe of public purchases in the country in 2011-2012. We compare the procurement behavior of public entities just above the cutoffs at which audits increase discontinuously, to public entities just below those cutoffs.

This analysis reveals that audits led to a strong reduction in the use of auctions and a corresponding increase in direct contracting as the contract awarding procedure. The shift surprised the leadership of the Chilean Comptroller Agency, since the government was actively promoting the use of auctions at that time. Comptrollers assumed that, if anything, being audited would induce entities to increase the use of auctions. They were especially concerned about our additional finding that more than half of the shift towards direct contracting is justified as "emergency", the justification which is known to be most prone to overuse.[1]

[1]This is the case not only in Chile but also in other settings, e.g. Robinson and Weigel (2018).

Next, we analyze whether the shift has real impacts. We find a significant reduction in competition: there is a particularly strong move away from auctions with more than three bidders and towards direct contracts that only require one quote. This has implications for the type of firms that win the contracts: more contracts are awarded to incumbents that have sold to the same entity before, as well as to small and local firms. Finally, we also find a substantial increase in prices within the subset of products for which we can compare prices and for which there is a sizeable shift towards direct contracts.

In order to shed light on the mechanism underlying the shift away from auctions, we worked with the Comptroller Agency to collect data to analyze the content of the audit itself. This type of analysis was not possible previously, as typical audit reports only include detected infractions, not information on the audit at the level of individual purchases. To overcome this data limitation, the Comptroller agreed to conduct additional audits to gather such micro-level information. These data revealed that, relative to comparable direct contracts, auctions undergo more than twice as many checks, lead to twice as many detected infractions, and are twice as likely to trigger follow-up investigations. This stems mechanically from the standard design of the audit protocol, which in Chile (as in many other jurisdictions) includes more potential checks for auctions than for direct contracts.[2] If agents run the risk of making a mistake in any given step of the process, procedures involving more steps, and correspondingly more checks, will mechanically lead to a higher probability of being found incompliant. When procurement officers learn that, despite the recent push for auctions by the government, using auctions leads to more problems during audits, this incentivizes them to use more direct contracting instead.

It is, of course, possible that the types of contracts for which auctions and direct con-

[2]The number of potential checks focusing especially on auctions is 53, whereas it is 18 for direct contracts. See Online Data Appendix A for the Chilean audit protocol. For the US federal government, see e.g. Office of Management and Budget (2018) and Governmental Auditing Standards and Title 2 U.S. Code of Federal Regulations (2020). For US state governments, see e.g. Minnesota Auditor General Office (2018), Arizona Auditor General Office (2020). For the EU see e.g. The Contact Committee of the Supreme Audit Institutions of the European Union (2018). For other countries, see e.g. Secretaría de la Función Pública de Mexico (2009) or Sri Lanka Auditor General's Department (2016).

tracting are used differ along observable or unobservable dimensions. We deal with this in two ways. First, we show that the differences in number of checks and detected infractions remain very similar when controlling for contract characteristics such as purchase amount and type of product. Second, we find that most of these differences stem from auditing of the awarding stage, where the process differs most between procurement procedures, rather than from the execution stage, which is very similar irrespective of procedure.

We also investigate two alternative mechanisms. First, entities might increase the use of direct contracts in year t because the likelihood of another audit in year $t+1$ might be low, and contracts awarded in year t might therefore be less subject to scrutiny. However, neither empirical evidence on re-audit probabilities nor interviews with procurement officers and auditors support this hypothesis. Second, the audits might increase the workload of procurement officers to the point that they fall behind and run into true emergencies. However, interviews with procurement officers revealed that being audited is only minimally disruptive in this context.

The new distortionary mechanism we identify in this paper is both simple and very general. It applies to any setting - in the public or private sector - where audits are designed to maximize the detection of infractions but agents have some discretion over the choice of procedure. This is typically the case in public procurement (see e.g. Spagnolo, 2012). While governments tend to promote the use of more transparent and competitive procurement procedures over direct contracts, exceptions are usually allowed for cases in which auctions are impractical or inefficient, such as in emergencies or when only one supplier is available. This leads to some discretion inherent in the choice of procurement procedure.

More generally, our results show that the widespread mechanical auditing approach that we call "auditing by checklist" can inadvertently discourage the use of more regulated, complex and transparent procedures that tend to involve more steps and leave a longer paper trail. This distortion can undermine underlying policy goals, unless the regulator actually

intends to discourage exactly such procedures. In many cases, however, the reverse is true. This has important implications for monitoring agencies aiming to design audit processes that keep incentives neutral across procedures. If agencies optimize audit design ignoring agents' discretion, this can lead to unintended distortions. We provide a simple conceptual framework to illustrate this mechanism and discuss potential ways to address it through differential penalties and audit probabilities.

This paper contributes to multiple strands of the literature. First, it extends past work on audits by demonstrating how international best practices can unintentionally reduce the use of competitive auctions in public procurement. Existing work finds that public sector audits reduce corruption (Avis et al., 2018), improve firm performance (Colonnelli and Prem, 2020) and increase electoral accountability (Ferraz and Finan, 2008). Similarly, an increase in audit *risk* has been shown to curb corruption in road construction (Olken, 2007) and public procurement (Zamboni and Litschig, 2018).[3] Scholars have also noted limited effectiveness in audits, such as inefficient targeting (e.g. Duflo et al., 2018), predictable timing (Gonzalez-Lira and Mobarak, 2019), substitution of illict behavior to other less measurable margins (e.g. Yang, 2008; Niehaus and Sukhtankar, 2013; Carrillo et al., 2017; Lichand and Fernandes, 2019), and the integrity and effort of auditors themselves (e.g. Kahn et al., 2001; Khan et al., 2016; Bandiera et al., 2019; Chu et al., 2020).[4] This paper furthers this literature by identifying a very general mechanism through which audits can undermine the very processes they are meant to improve. It is also the first paper we know of to analyze the role of the audit protocol in shaping the incentives and choices of bureaucrats under scrutiny.

Second, our paper contributes to the literature on public procurement by demonstrating that bureaucrats' choice of whether to use auctions or direct contracting is itself affected by

[3]In the case of taxes, Kleven et al. (2011), DeBacker et al. (2015), DeBacker et al. (2018) and Advani et al. (2019) analyze the impacts of audits of individuals in Denmark and the U.K, and of firms and individuals in the US, respectively, and Kleven et al. (2011) and Pomeranz (2015) study the effects of increased tax audit risk. See Pomeranz and Vila-Belda (2019) for an overview of recent research with tax authorities.

[4]In the case of government mandated, privately provided audits, limited effectiveness has been found to result from collusion (e.g. Duflo et al., 2013a,b).

widely used monitoring practices. Several recent studies empirically analyze the impacts of different procurement procedures.[5] These studies find improved outcomes under auctions compared to direct contracts in terms of lower prices and higher quality in rail services (Lalive et al., 2015), lower prices and more productive suppliers (Szucs, 2017), and more productive and less politically connected contractors (Baltrunaite et al., 2018). Similarly, comparing procedures with varying degrees of openness to competition, Auriol et al. (2016) and Zamboni and Litschig (2018) document that more open procedures are less likely to involve corruption. A second set of studies finds that increased accessibility of information can improve procurement outcomes such as increased entry, lower costs, better quality or reduced contracting times (e.g. Coviello and Mariniello, 2014; Lewis-Faupel et al., 2016; Kovalchuk et al., 2019).[6] This paper steps back and considers bureaucrats' incentives to choose auction-based procurement in the first place. Our findings reveal that audits can in fact discourage the use of auctions and shift procurement toward less competitive direct contracting with important consequences for real outcomes.

More broadly, the finding that audits effectively discouraged certain procedures by inadvertently subjecting them to disproportionate scrutiny highlights that optimal design of organizations is perhaps a poor description of how large institutions operate in practice (e.g. Simon, 1972). This seems to be the case even in a high-capacity, low corruption environment such as Chile.[7] For optimal audit design, organizations should take incentives across all margins of behavior into account (e.g. Stigler, 1970).

The remainder of the paper proceeds as follows. Section 2 provides institutional background and a simple conceptual framework. Section 3 describes the data. Section 4 discusses

[5]For an overview of the theoretical literature see e.g. Coviello et al. (2018).

[6]A related literature looks at the role of bureaucrats in public procurement management, finding that passive waste can play a more important role than active rent taking (Bandiera et al., 2009) and that higher bureaucratic competence can improve procurement outcomes (Decarolis et al., 2019). Finally, a number of papers, such as Tran (2011), Decarolis (2014), Coviello et al. (2018), Banerjee et al. (2019) and Decarolis et al. (2020) investigate how auction design affects efficiency in public procurement.

[7]In our study period, Transparency International ranked Chile as the 20th least corrupt out of 176 countries. For comparison, the US ranked 19th (Transparency International, 2012).

the empirical strategy and validity checks. Section 5 shows impacts on procurement procedures and Section 6 on competitiveness, suppliers and prices. Section 7 analyzes the underlying mechanism. Section 8 concludes and discusses implications for optimal audit design.

2 Background

2.1 Public Procurement

Procurement regulations typically include two main procedures to award contracts: direct contracting and public auctions. Under direct contracting, public entities make purchases directly from suppliers they select. In public auctions, purchasing entities need to specify the selection criteria explicitly in advance and any qualified firm can participate. Public auctions have a built-in control mechanism, in that the losers have a vested interest in checking whether the process was executed fairly and correctly and the winning supplier meets the specified criteria. If they suspect irregularities, they can launch a complaint. For all these reasons, public auctions are considered to be conducive to transparency and competitiveness and are often recommended over single source procurement methods (e.g. OECD, 2015; World Bank, 2016).

However, not all purchases lend themselves for auctions. In certain circumstances, conducting an auction can be inappropriate or inefficient (Bajari et al., 2009). This can be the case if there is only a single supplier in the market for a particular product; if there is an emergency, and the time it would take to organize an auction would lead to bigger problems; if the amount involved is small compared to the cost of organizing an auction, etc. Procurement regulations therefore typically allow for exceptions, under which auctions are not required and direct contracting is allowed. While procurement officers need to indicate the specific reason for using a single source approach, there is some discretion inherent in the choice of procedure.

Many countries have a third procurement procedure, so-called framework agreements. They are typically managed by a central agency, which runs auctions or negotiates conditions for products that are used by many public entities, such as office materials or cleaning supplies. Individual public entities can then simply order products from a list of options. Framework agreements are typically also considered a competitive procurement procedure, so when a product is available in a framework agreement, the entity does not need to organize an auction.

The Chilean Context

Chile Compra (henceforth the "Procurement Agency") is the government agency managing the public procurement system and the online platform on which most public procurement in Chile takes place. The platform serves practically all public entities in Chile[8] with about 1,350 entities making purchases, and over 100,000 firms supplying goods and services each year (Chile Compra, 2012). During our study period, purchases on the platform represented about 3.1% of GDP (Chile Compra, 2018).

Prior to our study period, the Procurement Agency started to increasingly promote the use of auctions and discourage the overuse of direct contracting, both through regulatory changes (Chile Compra, 2009, 2010d,b, 2016)[9] and trainings for procurement officers (Chile Compra, 2010c). While historically, most purchases used to be made through direct contracting, these efforts succeeded in motivating entities to conduct a large share of purchases through auctions, mirroring similar efforts in many other countries (see e.g. OECD, 2016b). During our study period, auctions represent the largest share of purchases, followed by direct contracts and framework agreement purchases. Auctions are conducted directly on the online platform, where all information about the bidding process and specifications is publicly

[8]There are a few exemptions such as for the armed forces. Large public works like construction of an airport or highway are not part of the online procurement system and are handled by a different agency.

[9]The 2010 regulatory changes introduced five new justifications for direct contracting which are listed as points 16-20 in Section C of the Online Data Appendix (Chile Compra, 2010b), and a new public auction type to hire specialized services that require highly technical knowledge or experience (Chile Compra, 2010a).

available. Once an auction is finalized, bids of all competing firms are also published there.[10]

The Chilean procurement regulation stipulates 21 possible justifications for the use of direct contracting. They include cases where only one supplier exists, emergency, situations in which organizing an auction would represent a disproportionate cost, or purchases with a total sum below about 750 USD.[11] Depending on the type of justification, procurement officers are required to get one or three quotes from suppliers. About 80% of direct contracts require one quote and about 20% require three. The awarding process for direct contracts is completed offline and information about the purchase is subsequently uploaded to the platform.

When a product is available through a framework agreement, entities are required to use this option, unless they can obtain better terms through another procedure. Products that are available through framework agreement but are purchased through other procedures therefore make up a very small share of total purchases. Finally, for small purchases below about 225 USD, the use of the electronic procurement system is not required.

2.2 Audits

Public Sector Audits

Supreme audit institutions or comptroller agencies[12] are in charge of monitoring public entities and state-owned enterprises. They play an important role for state capacity by enhancing public sector transparency, performance and accountability and ensuring correct execution of rules and regulations (e.g. INTOSAI, 2010; OECD, 2014). One of their primary

[10]Chile uses so-called "scoring-auctions" in which points are given to bids depending on a number of characteristics of the offer. The bid with the highest score wins the contract. These characteristics can include aspects relevant to the purchase value such as price, specific quality dimensions, experience of the supplier, qualification of their staff, etc. At a minimum, two characteristics need to be specified such that points are not only allotted based on price.

[11]The specific threshold is 10 UTM (Unidad Tributaria Mensual, an inflation-adjusted Chilean unit of account). See Online Data Appendix C for the full list of possible justifications.

[12]Known in different countries as "National Comptroller", "Auditing Agency", "Court of Auditors" or "General Accountability Office"

monitoring activities consists of implementing audits (INTOSAI, 2010), typically including a strong focus on procurement. Auditors from the comptroller agency usually visit the public entity being audited and work behind closed doors to examine documents.

Auditors often follow a checklist to investigate whether processes were executed in accordance with the regulation (e.g. The Contact Committee of the Supreme Audit Institutions of the European Union, 2018). In the case of public procurement, common checks include whether the corresponding steps in contract specification, supplier selection and contract execution were implemented correctly. Following the audit, many comptroller agencies issue a preliminary report with the detected infractions, and entities can file a response explaining how the infractions occurred and what they will do to remedy the issue. Taking the entity's response into account, the comptroller releases an official final report, which in many countries is publicly available.

The Chilean Context

Contraloría is the Chilean national comptroller agency (henceforth "Comptroller"). Compared to other countries, it is particularly well-functioning and well-funded (Engel et al., 2017). Appendix Figure A1 illustrates the relationship between Procurement Agency, Comptroller, and public entities which make procurements (such as hospitals, schools, ministries).

The timeline of the audits is as follows. At the end of each year t-1, the Comptroller determines which entities will be audited in year t. At the beginning of year t, selected entities are notified that they will be audited and told which documents they need to prepare. At this point, entities start getting a sense of what aspects of their procurement will be under scrutiny. Most audits begin early in the year, almost half in the first quarter. Audits usually examine completed contracts from year t-3 to year t-1. The impacts we measure are those on new purchases made in year t, which are not subject to the audit.

Audits last 2 months on average. Following standard procedure, contact between audi-

tors and entity staff is kept at a minimum and no social interactions are allowed. Upon receipt of a preliminary report after the audit, entities learn in more detail what the auditors focused on. During the following weeks, entities prepare their response to the interim report and officials who committed the infractions are required to explain themselves internally to their superiors. In our qualitative interviews, officials described this as a painful experience that can severely affect their career prospects. Based on the entity's response, the Comptroller releases a final report publicly on the internet.In severe cases, the Comptroller can initiate a formal investigation. This serious step can involve disciplinary proceedings, restitutions for improper payments, referral to the Court of Auditors to initiate a quasi-judicial examination, or referrals for legal prosecution to the Public Prosecutor.

2.3 Audit Selection Process

As is the case in many auditing agencies, the selection of entities to be audited depends in part on quantifiable criteria and in part on subjective, qualitative factors. To optimize cost-benefits, auditing agencies tend to target resources on entities that are large enough, and at high enough risk of malpractice to warrant the effort. At the same time, to maintain deterrence power, even small and low-risk entities need to be subject to some audits. Auditing agencies increasingly use scoring rules to weigh these different considerations.

In 2011-2012, the Chilean Comptroller used a secret scoring system with cutoffs to guide the decision of which public entities to audit. We exploit these cutoffs to measure the impact of being audited using a regression discontinuity design.[13] Among public entities that the Comptroller considered to be of medium non-compliance risk, the decision to audit depended in part on an "importance score".[14] This score combined different aspects of entity size such as budget, transfers to the private sector, etc., and ranged from zero to hundred.

[13]In later years, the scoring rule was changed such that there was no discontinuity anymore.

[14]Almost 60% of entities were considered medium risk. Among the 38% considered high risk, a large share was audited independently of their importance score, while among the 3% considered low risk, few were audited. The risk classification was based on factors like low compliance in previous audits or complaints from civil society.

Public entities of medium risk were divided into three groups according to their importance score: high, medium, or low. This ranking and the cutoffs were determined each year separately for each internal unit of the Comptroller.[15] We therefore refer to a stratum as a cell defined by year and internal unit. Within each internal unit, the Comptroller divided the range of the score into three equally-sized parts that determined the cutoffs. The calculation of the score was kept secret within a small team at the central control office, and the existence of the score was not known to entities subject to the audit. Entities only learned whether or not they had been selected for an audit, no justification was given.

2.4 Conceptual Framework

The following provides a simple conceptual framework to illustrate the challenge of avoiding distortions by audit when agents subject to the audit have some discretion over multiple procedures. Beyond public procurement, this applies to many contexts, such as medical professionals deciding whether to use a shorter or a more complex procedure, sales staff choosing whether to sell a simpler or more expensive but complex service, etc.

Consider two such procedures, $j = \{1, 2\}$, that differ in the number of auditable steps involved in their execution. In our context, the procedure with fewer steps is direct contracting, while the alternative, longer procedure is an auction. Many factors may affect whether agents choose procedure 1 or 2.[16] One key consideration we focus on here is that at each step k, agents run the risk of making a mistake leading to an infraction.[17] The probability ϵ of an infraction can be reduced by exerting additional effort to avoid mistakes.

We start by considering the agent's problem, building on the standard Becker deterrence model of crime (e.g. Becker, 1968). Agents choose the level of effort to reduce the risk of making infractions, taking into account the effort cost and the expected penalty. Infractions

[15] Each internal unit is responsible to monitor and audit a group of public entities.

[16] In the context of public procurement, these include for example whether there are enough suppliers in the market, or whether the amount of the purchase is large enough to warrant an auction, as well as potential private benefits in the form of differential opportunities for corruption across procedures.

[17] In an auction for example, the agent may write an incomplete specification of the call for bids.

are detected with probability p_k, and agents receive sanction s per detected infraction.

The auditing agency attempts to deter infractions. If, as is often the case, the sanction is given by law and not a choice variable for the agency, deterrence will be maximized by maximizing the likelihood of detection p_k. The agency chooses which steps to audit and with what intensity. Define as n the total number of auditable steps executed by the agent (across all procedures). The probability of detection $p_k = p(h_k)$ in a given step is increasing in audit hours h_k, $p'(h_k) > 0$. The agency's problem is then to maximize the likelihood of infraction detection $\sum_{k=1}^{n} p(h_k)\epsilon$, subject to a budget constraint $\sum_{k=1}^{n} h_k = B$. The n first order conditions are $p'(h_k^*)\epsilon = L$, where L is the Lagrange multiplier associated with the budget constraint.

If there are decreasing returns to auditing hours within a given step, then $p(h_k)$ is concave in auditing hours, $p''(h_k) < 0$. In this case, $h_k^* = B/n$ maximizes the detection probability: it is optimal for the auditing agency to investigate each auditable step with the same intensity. This may explain why the "auditing by checklist" approach is so common. If on the other hand $p(.)$ is non-concave or if there is a fixed cost to auditing each step, then the objective function is maximized by selecting a subset of steps and auditing them fully. If the budget constraint is binding, such that not all steps can be audited, optimizing agencies will randomly select steps to be audited.

The following shows that this approach will mechanically lead to a higher expected penalty for procedures j involving more auditable steps. For the concave case, consider the expected number of discovered infractions per procedure, $E_j = n_j p(h_k^*)\epsilon$. The ratio of expected discovered infractions for two procedures is then

$$\frac{E_2}{E_1} = \frac{n_2 p(h_k^*)\epsilon}{n_1 p(h_k^*)\epsilon} = \frac{n_2}{n_1}.$$

A similar result obtains for the non-concave case, where every step has the same probability of being randomly selected for audit. So irrespective of whether there are increasing or

decreasing returns to audit hours within a given step, procedures with more steps lead to a higher number of expected infractions and associated sanctions. If, for example, procedure 2 has twice the number of steps as procedure 1, the expected number of discovered infractions will be twice as high in procedure 2.

In settings where agents have no discretion over the choice of procedure, maximization of deterrence for each auditable step independent of procedure has no further implications. However, if agents do have some discretion, this gives rise to a distortionary incentive against procedures with more auditable steps. Switching to a procedure with fewer auditable steps allows agents to reduce their expected detected infractions without increasing effort to avoid mistakes.

Eliminating this distortionary incentive would require equalizing the expected number of discovered infractions across the two procedures $E_2 = E_1$. In the non-concave case, auditors can achieve this simply by randomly sampling fewer steps of the longer procedure, such that the number of audited steps is equal across procedures. In the concave case, equalizing the expected number of discovered infractions requires increasing audit hours per auditable step in procedure 1 relative to procedure 2 such that

$$\frac{p(h_{k1})}{p(h_{k2})} = \frac{n_2}{n_1}.$$

Steps in the shorter procedure 1 are then audited more intensely than in the longer procedure 2. But given the decreasing returns to auditing intensity within a given step, the marginal detection likelihood is now lower in the shorter procedure $p'(h_{k1}) < p'(h_{k2})$ and this deviation from h_k^* fails to maximize the overall number of detected infractions. In the concave case, there is therefore a trade-off between removing the distortionary incentive and maximizing detection of infractions.[18]

[18]The extent of the distortion is mitigated or amplified depending on the relative likelihood of a mistake. The distortion would be mitigated or even reversed if $\epsilon_1 > \epsilon_2$. In this case the auditing agency would naturally want to increase monitoring of the shorter procedure, such that $p'(h_{k1}^*)\epsilon_1 = p'(h_{k2}^*)\epsilon_2$. With a concave detection probability, this would require increased audit hours in the shorter procedure, leading to

Whether it is optimal to eliminate the distortion depends on several factors, including a) the extent to which the choice of procedure is affected by the differential number of detected infractions and b) the social cost of distortions in the choice of procedure. In the case of procurement, a) relates to how strongly procurement officers shift from auctions to direct contracting when learning that the former leads to more detected infractions.[19] The social costs b) of this distortion can include, for example, higher prices for public expenditures or higher barriers to entry for new firms.

Optimal audit design should take these considerations into account. The government could instruct the auditing agency to not only maximize detection of infractions, but to also include minimizing distortions between procedures into the agency's objective function. This would likely require including more economists or other experts trained in analyzing incentives in audit design, in addition to the legal experts usually involved in this task. Additional policy instruments may also help mitigate the trade-off in the concave case. For example, the regulator could apply higher sanctions for infractions in the shorter procedure in order to offset the distortionary incentive.

3 Data

We combine transaction-level data from the Procurement Agency with audit data from the Comptroller.[20] To complement these administrative data sources, the Comptroller conducted additional audits to collect information on what happens during procurement audits, including which contracts are audited, which checks are executed, and what infractions are found. Finally, we conducted a number of interviews with procurement officers.

an increased likelihood of detection in a given step, compared to the longer procedure $p(h_2)/p(h_1) < 1$.

[19] Such updating can happen in particular when agents are not previously aware of this pattern – for example because audit protocols recently changed or because the auditing agency announced that it would pursue more vigorously the overuse of the shorter procedure, as is the case in our context.

[20] Online Data Appendix B explains the construction of the dataset.

3.1 Data on Procurement

We collected data from the Procurement Agency on the full universe of purchases conducted on the online platform. For each purchase, this includes the purchasing entity, purchase procedure, justification in case of direct contracts, number and characteristics of bidders in case of auctions, date of the purchase, 8-digit product codes, verbal description of each item, value of the purchase, quantity purchased, unit of measurement, and identification number and characteristics of the seller (e.g. firm size, location).

Table 1 Panel A presents summary statistics for the universe of purchases in our estimation period. With 4.4 million purchases for USD 6.6 billion, auctions make up about 51% of purchases and 64% of amounts spent, while direct contracts represent around 15% of purchases and 18% of amounts spent. The average number of quotes obtained per direct contract is 1.4, while an average of 13 bidders compete in public auctions. Framework agreements cover about 27% of purchases, but only 17% of total dollars spent, as they are commonly used for lower-cost purchases, such as office supplies or cleaning materials. Finally, about 7% of purchases but less than 0.5% of the value was for very small purchases, for which use of the electronic procurement platform is optional. Panel B shows the same statistics for entities in the estimation sample, i.e. those of medium risk within a ± 10 range around the cutoff of the importance score. The numbers are quite similar.

3.2 Data on Audits

Administrative Data

The Comptroller provided data on audits (which entities were audited and when), on the importance score and the risk classification of each public entity, as well as on the internal unit in charge of monitoring each entity. We also collected information about the political affiliation of the leadership of each entity based on public information from the Chilean

Electoral Service (Chilean Electoral Service, 2014) to construct a control variable.[21]

Additional Audits

Information routinely collected by the Comptroller during audits was rather limited at the time. It included only the detected infractions, but no data on which purchases were audited and what checks were conducted. Findings from many purchases were grouped together, so that it was not possible to study differences by procurement procedure. This limits the scope of possible analyses of what happened during the audits in our RDD sample.

To shed more light on the audit process, the Comptroller agreed to undertake additional audits to collect more information. These audits were conducted in the same way as usual, with the key difference that auditors recorded more information, namely which contracts were audited, which checks were applied and which infractions were detected for each contract. This allows us to examine differences in the way auctions and direct contracts are audited in terms of the number and type of checks applied and the frequency and severity of detected infractions. The audits in the RDD analysis took place in 2011-2012, while the additional audits were implemented in 2015 (see Appendix Figure A2 for a timeline). However, the audit protocol of the Comptroller remained unchanged.

The audit protocol includes 95 checks, most of which correspond clearly to either the contract awarding or the contract execution stage. The contract awarding stage includes all steps leading up to awarding of the contract, such as choosing the procurement procedure, writing the specifications for auctions, requesting quotes for direct contracts, and evaluating the bids or offers. The contract execution stage refers to all activities following contract awarding, such as timing of delivery, quality of the product or service, and delivery according to specification.[22] The additional audits took place in two waves in July and September 2015.

[21] Political affiliations are right wing coalition, left wing coalition, or independent. National and regional entities were assigned to the right-wing coalition since they were part of the right-wing coalition government in office at that time. Affiliation of municipal entities was assigned according to the mayor.

[22] Online Data Appendix A shows the audit protocol and classifies checks by awarding or execution stage.

Eighteen out of 1,278 entities were selected randomly from internal units that had remaining auditing capacity. In each entity, the Comptroller audited three purchases of goods and up to three purchases of services, for a total of 105 audited contracts.[23]

4 Empirical Strategy

4.1 Regression Discontinuity Design (RDD) Specification

Based on the audit-selection process described in Section 2.3, we estimate the impact of an audit by comparing entities above and below the cutoffs in the importance score. While these entities are otherwise similar, a higher share of those above the cutoff is audited. We use a fuzzy RDD, since factors other than the importance classification are also taken into account when entities are selected for audit. The RDD captures the effect for entities classified as medium risk in the vicinity of the cutoffs. In terms of external validity, this implies that we measure impacts on relatively "typical" entities, which are in the middle of the risk distribution and neither extremely large nor extremely small.

Since cutoffs were determined separately in each stratum, we normalize scores at the stratum level, so that the normalized score indicates distance from the cutoff (following e.g. Kaufmann et al., 2013; Pop-Eleches and Urquiola, 2013; Hastings et al., 2014). Our main specifications include stratum fixed effects and entity characteristics as controls.[24] The location of the significant discontinuity varied across years.[25] In our period, the discontinuity occurred between low and medium levels of importance in 2011 and between medium and high in 2012. We therefore focus on these two cutoffs in our main specifications. For robustness, we also provide estimates that pool across all four potential cutoffs.

[23] A few entities had less than 3 service contracts during the audited period.

[24] For robustness, we also run regressions with interactions of stratum dummies and distance to the cutoff.

[25] The share of entities audited was generally low among entities with low importance score and high among those with high importance score. For entities in the medium range, the audit rate depended on the available auditing resources in a given year.

The linear specification for observations within a distance h of the cutoff is as follows:

$$D_{ij} = \pi \mathrm{I}[X_{ij} \geq 0] + \rho_0 + \rho_1 X_{ij} + \rho_2 X_{ij} \times \mathrm{I}[X_{ij} \geq 0] + S_j + \gamma W_{ij} + V_{ij} \quad (1)$$

$$Y_{ij} = \tau \mathrm{I}[X_{ij} \geq 0] + \beta_0 + \beta_1 X_{ij} + \beta_2 X_{ij} \times \mathrm{I}[X_{ij} \geq 0] + S_j + \theta W_{ij} + U_{ij} \quad (2)$$

where Y_{ij} is an outcome for entity i in stratum j; D_{ij} a dummy equal to 1 if an entity is audited; X_{ij} the importance score normalized with respect to cutoff c_j, $\mathrm{I}[X_{ij} \geq 0]$ an indicator for an importance score above the cutoff; τ the effect of crossing the cutoff on outcome Y_{ij}; S_j the stratum dummies; W_{ij} a vector of entity characteristics; U_{ij} and V_{ij} are error terms. Control variables include: a dummy for having been audited a year prior to treatment,[26] dummies for entities' political affiliation, as well as first and second lags of log (+1) of the total amount purchased by the entity, of the shares of purchase amounts made through auctions and direct contracts, and of the outcome variable (where the outcome is different from auction or direct contracting shares).

Our analysis of impacts on purchase procedures is at the level of the public entity. For effects on supplier characteristics and prices, we use data at the purchase level to control for additional factors such as month of the purchase and product-unit fixed effects.[27] Standard errors are clustered at the stratum level. We focus on reduced form estimates to maintain a close correspondence with the graphical evidence and to avoid potential weak instrument problems (Chernozhukov and Hansen, 2008; Feir et al., 2016).

The normalized distance to the cutoff ranges from -62.5 to 38.9. We use four different specifications: 1) Local linear regressions around the cutoffs following Hahn et al. (2001) and Imbens and Lemieux (2008). 2) Quadratic specification in a larger bandwidth following Lee and Lemieux (2010). Based on visual inspection, these specifications use bandwidths of ± 4 and ± 10 respectively.[28] 3) Outcome-specific bandwidths that are Mean Square Error-

[26] Audit data are only available for one year prior to 2011.

[27] These are dummies for each product by unit of measurement, e.g. kilograms of salt.

[28] These estimations use a rectangular kernel, which in effect amounts to giving higher weight to observa-

optimal using triangular kernels as proposed by Imbens and Kalyanaraman (2012) as well as 4) the same bandwidths with bias-corrected estimates and robust standard errors following Calonico et al. (2014).[29]

4.2 Additional Audits Specification

The data from the additional audits allow us to analyze audits by purchase procedure. We run OLS regressions of the number and type of checks and infractions on whether a purchase was done through auction or direct contracting. Clearly, the purchase procedure is not exogenous. We undertake two steps to investigate whether the differences in the number of checks and infractions are indeed related to the purchase procedure and not based on other differences between the purchases.

First, we show that results are robust to the inclusion of key covariates: product dummies, month of the purchase, amount of the purchase, month of the audit, and internal unit implementing the audit. Second, we analyze results separately for the awarding and execution stages of the contract (as defined in Section 3.2). While the awarding process differs substantially between purchase procedure, the execution stage is similar. If differences in the number of checks or detected infractions are mostly concentrated in the awarding stage, this would suggest that the purchase procedure itself is likely driving these results, rather than unobserved differences between purchases made through direct contracts and auctions.

4.3 RDD Internal Validity Checks

The RDD effects are identified under two main assumptions. 1) No other characteristics change discontinuously at the cutoff. 2) The exclusion restriction - crossing the cutoff does

tions closer to the cutoff.

[29]Originally, we also intended to include subgroup analysis of differential impacts by different types of entities or products. For this, we developed a new empirical approach based on propensity score reweighting, which allows running RDD analysis by subgroup while holding other characteristics constant (see description and Stata code in Carril et al., 2018). Unfortunately, there is not enough statistical power to detect any potential differential impacts in our data.

not affect outcomes through any other channels.

As shown in Lee and Lemieux (2010), a sufficient condition for the first assumption is that the density of the variable determining treatment assignment is continuous. This is fulfilled if there is no precise manipulation to be on either side of the cutoff. This is likely the case here for the following reasons. As discussed above, the existence of a score is unknown to public entities. In addition, the cutoffs are determined after all scores have been calculated, and are based on the range of the score in a particular stratum. So entities would not only need to know their own score, but also every other entity's score, to be able to locate precisely on the side of the cutoff with lower share of audited entities. Also, the components of the importance score change each year. Finally, the fact that the cutoff does not shift the share of audited entities from zero to one reduces the incentives for such manipulation. If a control department and a public entity wanted to collude, it would be easier to simply not select that entity for audit, rather than manipulating its score.

While the assumption of continuity is not directly testable, it has testable implications. Figure 1 shows results of a McCrary density test (McCrary, 2008). Consistent with no manipulation, the test does not reject the null hypothesis that the density is smooth around the cutoff (log difference = -0.1, standard error = 0.2). Table 2 tests for imbalance of covariates at the cutoff. Columns (1) and (4) show comparison means, i.e. estimated means to the left of the cutoff, based on the RDD specifications. Columns (2) and (3) show linear discontinuity estimates as in Equation (2), with the covariates as outcomes in the ± 4 range without and with stratum fixed effects. Columns (5) and (6) show the same for quadratic estimates in the ± 10 range. Variables are either time invariant or from the pre-treatment period.

The p-values of the F-tests for joint significance of all variables range from 0.59 to 0.74, indicating no significant discontinuity at the cutoff. However, not all characteristics have point estimates that are close to zero, and in one of the four specifications, a pre-treatment

outcome is significantly different from zero at the 10% level. Our preferred specifications therefore control for all variables in Table 2. For outcomes other than direct contracting and auction shares, we also control for the first and second lags of the outcome variable. Finally, we also show impacts on the main outcomes (purchases via auction and direct contracts) on a quarterly basis over time, to confirm that the impacts start at the time of the audit.

The exclusion restriction is unlikely to be violated in our context given that the running variable is an internal score constructed by a small unit within the Comptroller Agency, not shared with other departments. Moreover, the score is different for every stratum and in every year. In our extensive conversations with many representatives at the Comptroller Agency, it became clear that this score was not used for any other purpose.

5 First Stage and Impacts on Purchase Procedures

5.1 RDD First Stage: Effect on the Share of Audited Entities

Figure 2 presents first stage results pooling across 2011 and 2012.[30] The x-axis represents the importance score normalized by stratum-specific cutoffs. The y-axis shows the residual share of audited entities after controlling for stratum fixed effects and the control variables. Each dot represents a two-point wide bin. Linear and quadratic fitted lines are also included.

A number of aspects stand out. First, there is a jump in the share of audited entities at the cutoff. Second, the share of audited entities is generally increasing with the importance score (i.e. moving from left to right in the figure), but this increase is not linear. As discussed above, the choice of which entity to audit within a level of importance is based on subjective considerations, which can result in non-linearities. This does not affect our estimates, which are based solely on the discontinuity at the cutoff.

[30] As discussed in Section 4.1, based on the audit selection process, the significant discontinuity can differ for different years. It occurs between low and medium levels of importance in 2011 and between medium and high in 2012. Our main specifications therefore focus on these cutoffs. For robustness, we also report estimates pooling all four potential cutoffs. See Table A1 in the Appendix for the corresponding first stage.

Table 3 displays the first stage numerically for 8 specifications: Columns (1) to (3) show a bandwidth of ±4 and a linear spline whereas Columns (4) to (6) show a bandwidth of ±10 and a quadratic spline with varying inclusion of covariates. Column (7) employs the optimal bandwidth proposed by Imbens and Kalyanaraman (2012) and Column (8) adds bias-corrected RD estimates and robust standard errors proposed by Calonico, Cattaneo and Titiunik (2014). All estimates are statistically significant at the 5% or 1% level. In our preferred specifications with control variables, i.e. Columns (3), (6), (7) and (8), the share of audited entities increases at the cutoff by 15.8 to 19.3 percentage points.

5.2 Effects on Purchase Procedures

Next, we analyze the impact on the share of purchase amounts by procurement procedure. Figure 3 presents the graphical evidence. Public entities just to the right of the cutoff have a lower share of purchase amounts with auctions (Panel A) and a higher share of direct contracts (Panel B). The similar magnitude and opposite direction suggest that entities increase direct contracts at the expense of auctions. Panels C and D show no impacts on procurement made through framework agreements or as small purchases.

Table 4 displays the results for auctions and direct contracts in regression form, following Equation (2). Results are quite robust across specifications, even though magnitudes and levels of significance vary. In our preferred specifications, i.e. including control variables, the estimates range from -6.9 to -8.9 percentage points for auctions and from 6.1 to 7.7 percentage points for direct contracts. Undergoing an audit therefore seems to induce public entities to reduce the use of the more transparent and competitive procedure of public auctions and to increase the use of direct contracts.[31]

[31] For robustness, we also estimate these effects including interactions between stratum dummies and distance to the cutoff (Table A3). This allows for the relationship between outcome and running variable to differ within each stratum. Results are quite similar. We also show reduced form estimates pooling across all four potential cutoffs (Table A4). Results are similar in terms of the sign of the effects but with smaller coefficients, as expected given the smaller first stage. Finally, the result does not stem from a change in total amounts purchased, as shown in Table A2 in the Appendix. This is not surprising since Chilean legislation does not allow entities to deviate substantially from their annual budget.

Since these are reduced form results, estimating the impact of an audit would require scaling them up by the inverse of the first stage. This would suggest an impact of 34 to 41 percentage points in the specifications with controls for the shift towards direct contracts and 38 to 48 percentage points for auctions, which seems quite large. However, these specific point estimates have to be interpreted with caution, both because the standard errors are large and because the first stage estimates may be too weak to provide reliable IV inference (Chernozhukov and Hansen, 2008; Feir et al., 2016).

To further assess whether the effect indeed stems from the audits, we also show the evolution of the effect over time. Figure 4 shows the effects on a quarterly basis for two years before to two years after the beginning of the audit. While the quarterly results are relatively noisy, there is no impact in the "placebo" pre-treatment periods. The effect starts at the beginning of the audit year and grows over the course of that year. This may reflect that, as discussed above, entities begin to learn about the content of the audits in the first part of the year, and additional information is revealed over the course of the process.

The effect then starts to decrease over the following year. It might seem a priori surprising that the effect is relatively short-lived, if it is a result of entities learning during the audits that purchases made by auction undergo more scrutiny than those made through direct contracts. Several factors might drive this dynamic. On the one hand, the difference between treated and comparison entities falls when comparison entities catch up. This can happen for two reasons. First, many entities that are below the cutoff in one year are audited in the following year. Second, information that the audit protocol did not reflect the recent official push for more use of auctions is likely to spread among procurement officers across the different entities. On the other hand, the effect may have waned within the treated entities themselves, both due to staff turnover and because entities could reasonably expect that the audit protocol would continue to evolve, due to continued regulatory changes (Chile Compra, 2016).

Overall, the results suggest that being audited induced entities to reduce the use of auctions for their subsequent purchases and increase the use of direct contracts instead. Next, we examine what type of justification was used for these additional direct contracts, and what type of contract sizes were most affected.

Direct Contracting Justifications

Entities need to provide a justification for using direct contracts. Analyzing which justifications drive the higher use of direct contracting in audited entities can shed additional light on the mechanism. Out of the 21 possible justifications, the emergency justification is known to be particularly prone to overuse and mentioned as such in the regulation. This is both because it is difficult to monitor ex-post, whether a purchase was indeed urgent, and because if a buyer waits long enough, almost any purchase can become justifiable on emergency grounds (Robinson and Weigel, 2018).

Table A5 shows RDD estimates for the five most frequent justifications and all other justifications grouped together. Recall that the shift towards direct contracting around 7 to 9 percentage points of amounts purchased. Over half of this increase is based on the emergency justification. Direct contracting using the emergency justification is 4 to 5 percentage points higher above the threshold, compared to base share of 0.8 to 1.4 percentage points. All specifications are significant at the 1% or 5% level. Direct contracts using the unique supplier justifications start at a higher base share of around 2.5 percentage points and increase by 1.2 to 1.8 percentage points (varying from insignificant to significant at the 5%-level). The coefficients for the other justifications are small and not significant.

The finding that the increase in direct contracting is driven to a large degree by the justification most prone to overuse is consistent with the interpretation that after an audit, procurement officers intentionally increased the use of direct contracting, using the justification that is the easiest to manipulate.

Contract Size

One potential concern regarding the relevance of the procedure shift is the size of the affected contracts. Are the effects concentrated on relatively small purchases, for which using an auction may not be worthwhile? Table A6 in the Appendix shows that on the contrary, the shift seems to stem mostly from contracts of above-average size.

6 Effects on Competition, Suppliers and Prices

6.1 Competition

One reason many governments promote auctions over direct contracting is that auctions are believed to be more competitive. However, a move from auctions to direct contracting does not necessarily imply a decrease in the number of competitors, since some auctions only attract a small number of bidders and certain direct contracts require 3 quotes from different firms.[32] If the reduction in auctions stems mainly from auctions with few bidders, while the increase in direct contracting stems mainly from cases requiring three quotes, the number of competitors involved might not actually fall or could in principle even increase.

Table 5 presents regression results estimating the impact on auctions and direct contracts with high vs. low number of competitors. Following the Procurement Agency's assessment, we classify an auction as competitive if it has more than 3 bidders. Panels A and B show that most of the shift goes from competitive auctions to direct contracts requiring only 1 quote. The reduction in auction share is, if anything, larger among auctions with more than 3 bidders (Panels A and C). At the same time, the entire increase in direct contracts stems from purchases based on only one quote (Panels B and D). Overall, there is a reduction in the share of purchases made through a competitive process (more than 3 competitors) by 5 to 8 percentage points.

[32] As discussed above, direct contracts require 1 or 3 quotes, depending on the justification given. Only one quote is required in cases of unique supplier, emergency, trust in suppliers and disproportionate cost of holding an auction.

6.2 Type of Suppliers

One important measure of whether there were real economic impacts beyond the reduction in the number of competitors is whether this affected the type of supplier that won the contract. Specifically, less competition might benefit incumbent firms with pre-existing contracts with the procuring entities (Coviello et al., 2018), smaller firms that might not be able to compete in an open competition, and local suppliers who might have more direct connections with the procuring entities (Lewis-Faupel et al., 2016).

When analyzing effects on the type of suppliers that win the contracts, an additional assumption is required to attribute these effects to the procedure shift: that the audits do not have a direct effect on these outcomes. Specifically, being audited cannot induce public entities to sell more to incumbent, small, and local firms for other reasons than the shift from auctions towards direct contracts. A similar assumption is required for the analysis of impacts on prices in the next subsection. While this is not testable, if anything it would seem plausible to expect the direct effect of an audit to go in the opposite direction (consistent with findings by Colonnelli and Prem, 2020).

Table 6 displays impacts on supplier characteristics. Panel A shows a reduction for new suppliers that have not sold to this entity before (within the 4 preceding years for which we have data). Their probability to win a contract falls by 2.4 to 4.6 percentage points. This is quite substantial compared to the baseline probability of around 17%. The coefficient is statistically significant for three out of our four main specifications. Panel B shows that the probability of large firms winning contracts also falls, by between 4.8 and 7.2 percentage points from a baseline of around 30%.[33] The effect is significant at the 1% or 5% level. Finally, Panel C analyzes the impact on suppliers from another region. The chance of suppliers who are not local to win a government contract falls by between 3.4 and 6.5 percentage points, from a baseline of around 45%, significant at the 5% to 10% level.[34]

[33]The Chilean tax authority officially classifies firms with over about USD 4 million in sales as large.

[34]The analysis by region excludes entities in the Metropolitan Region (RM), since a large part of the

Overall, these results show real impacts on suppliers competing to win government contracts. The fact that the shift away from auctions came with an increase of contracts given to small, local, incumbent suppliers is consistent with the view that direct contracting facilitates favoritism of insiders with special connections to the procuring entity.

6.3 Prices

The shift towards less competition and more incumbent, small, and local suppliers raises the question whether this leads to higher prices. However, measuring impacts on prices is notoriously difficult, and we will have to restrict this analysis to a small subgroup of products, for which this is possible. There are three challenges in this regard.

First, for many purchases there are no clear units of measurement in the data. Purchase orders may contain measures such as "a sack of rice", or "a month's supply of gas", a "training workshop in IT". Such vague units do not allow for a reliable comparison of prices. We therefore have to restrict the analysis to purchases with clear units of measurement such as meters, liters, or kilograms. This leaves about 7.6% of the total number of purchases and 2.2% of the value of purchases.[35] This price analysis therefore does not necessarily generalize to other types of purchases. Impacts on purchases without comparable units, such as many services, may be different. In particular, selection criteria for such purchases are typically more difficult to specify ex-ante, making it more challenging to procure them efficiently through auctions.

The second challenge is that when we implement the RDD among products with clear units of measurement, there is no significant overall shift in purchase procedure. This may be expected, since these products are more standardized and therefore more likely to be

Chilean economy is based there, so that the vast majority of purchases by entities in that region are from firms in the same region. This analysis therefore focuses on purchases from entities in other regions, for which it is more likely that competitive suppliers exists outside the region. Appendix Table A7 shows results including entities from RM. As expected, estimates are much smaller.

[35]The biggest categories among the purchases with comparable units of measurement are foods, fuel and hardware. The biggest category of purchases with non-comparable units are services (60% of the value).

always purchased through the same procedure, including framework agreements. To be able to analyze a sample in which there actually is a shift in procurement procedure, we do the following. First, we run RDD regressions for each product to estimate the shift in the auction share. We then divide the products into two groups: those with above-median and those with below-median absolute size of procedure shifts. The analysis of the impact on prices focuses on the former group. In the below-median effect group, as expected, we find no effect on prices.[36]

Third, while we control for 8-digit product fixed effects and focus on products with comparable units, we cannot control for potential unobserved quality differences. It is possible that having more discretion when using direct contracts, purchasing officers choose supplies with unobserved higher quality. At the same time, it is important to remember that auctions in Chile are not first price auctions, but scoring auctions, which allow purchasing entities to award contracts based on points for quality and previous supplier experience as well.

All that said, Table 7 shows RDD estimates on the log of unit prices in the sample of products with comparable units and above median procedure shift. Prices increase quite substantially, by about 10 to 15%, significant in 3 out of the 4 specifications. Combined with the finding above of a shift towards lower competition and different types of suppliers, these results suggest that there were real economic distortions resulting from the audits.

7 Mechanisms

7.1 Differential Scrutiny of Auctions and Direct Contracts

In order to gain a better understanding of the mechanisms that might lead to the impact of audits on the purchase procedure, we worked with the Comptroller to collect more

[36]The median effect on auctions is a reduction of 30% in the group with above-median shifts and an increase of 7% in the group with below-median shifts. See Online Data Appendix B for a detailed description of the steps involved in this analysis. For the results in Table 7, we implement this process using entities in the ±4 bandwidth. As a robustness check, Appendix Table A8 shows the results for purchases selected using entities in the ±10 bandwidth. The estimates are quite similar.

detailed data through additional audits, as described above. This allows us to compare the audit process for purchases made through auctions with those made through direct contracts.

Figure 5 displays the number and type of checks and detected infractions by whether a purchase was done through auction or direct contracting. As discussed in Section 4.2, we deal with the potential differences in the type of contracts for which auctions and direct contracts are used in two ways. First, we add purchase-level controls for the amount of the purchase and product codes, month of purchase, responsible internal unit, and month of the audit. The left-hand set of bars in Panel A show that purchases made with direct contracts undergo around 19 checks on average. In contrast, contracts made through auctions undergo about 32 more checks, for a total of almost 51 checks on average, 2.7 times as many as direct contracts. Table A9 in the Appendix shows the same analysis as in regression form, both with and without controls. The results are very similar (31.67 additional checks with controls and 31.74 without).

Second, we analyze the impact separately for the contract awarding stage (which is directly affected by the purchase procedure) and the execution stage. The middle and right-hand set of bars in Panel A show the number of checks separately for these stages. About 90% of the difference in the number of applied checks between purchase procedures stems indeed from the awarding stage. The number of checks in the contract awarding stage is 4.9 times larger for auctions than for direct contracts. This suggests that the bulk of the difference is related to differences in the procurement procedure.[37]

Next, we analyze whether the higher number of checks results in a higher number of detected infractions. The left-hand set of bars in Panel B show that purchases via direct contracts have an average of 1.8 detected infractions. Purchases by auction have 2.7 more detected infractions. The middle and right-hand set of bars in Panel B show detected in-

[37]The few additional checks in the execution stage could either be a result of auditors conducting more checks in the execution stage in cases where they find more infractions in the awarding stage, or it could be due to remaining unobserved differences.

fractions separately for the awarding and the execution stage. Over 80% of the difference in detected infractions stems from the awarding stage. Appendix Table A9 shows all these results in regression form. In addition, Column (7) displays the probability of a contract having a detected infraction so serious that it is marked for an investigation by the Comptroller. The likelihood of an investigation is 9 to 12 percentage points higher for purchases made through auctions than through direct contracting. However, the effect is only marginally significant at the 10% level.

Overall, these findings suggest that purchases made through auctions are subject to more scrutiny than those via direct contracts. Procurement officers who follow the government's recommendation and use auctions for their purchases are therefore more likely to be found incompliant in an audit, compared to those who use more direct contracts. As a result, this mechanical "auditing by checklist" approach may inadvertently discourage the use of auctions. Procurement officers who realize that the current auditing protocol leads to relatively more scrutiny for auctions compared to otherwise similar direct contracts may choose to reduce their use of - already more work-intensive - auctions and increase the use of direct contracts instead. More generally, mechanically checking each step of a regulation, as is done in many types of audits, may disincentivize the use of processes that involve more steps and leave a longer paper trail.

7.2 Alternative Explanations

Does the Subsequent Audit Probability Fall?

One alternative explanation we originally considered was a change in the subsequent audit probability. Specifically, entities might increase the use of direct contracts in year t because the likelihood of an immediate re-audit in year $t+1$ might be low, and contracts awarded in year t might therefore be less subject to scrutiny. However, both quantitative and qualitative evidence suggest that this is unlikely. Appendix Table A10 shows that if

anything, the audit probability in year $t+1$ is slightly higher to the right of the cutoff.

In addition, we conducted a number of focus groups and interviews with auditors at the Comptroller Agency and with procurement officers at over twenty public entities. Both auditors and procurement officers asserted that it would be unreasonable for procurement officer to expect less scrutiny following an audit for two reasons: first, they (correctly) asserted that the audit probability was not lower in the year following an audit. Second, many participants said that even if the audit probability were to temporarily fall in the year following an audit, that would not leave entities "protected" from scrutiny, since audits typically covered contracts from several prior years.

Congestion

Another hypothesis we originally considered was that audits might increase the workload for officers to the point that they fall behind on procurement work, leaving them with less time to implement auctions and leading them to resort to direct contracting. However, the interviews with the procurement officers revealed that this hypothesis was unrealistic. Respondents reported that the audits were only minimally disruptive to their work, since there was minimal interaction with the auditors and all that was required of them was to provide the auditors with the documentation of past procurement processes. Officers reported that this took no more than a couple of hours of their time.

8 Conclusion

This paper investigates the role of audit design in the context of public procurement in Chile. We first analyze the impacts of government audits on procurement practices. Contrary to the official policy goal, audits led to a reduction in the use of public auctions and a corresponding increase in the use of the less transparent and less competitive purchase procedure of direct contracting. The increase is concentrated among direct contracts justified by emergency, which are particularly prone to overuse and only require a quote from one

firm. At the same time, there is a large reduction in auctions with more than 3 bidders, so the overall competitiveness of the procurement process falls. The reduction in competition seems to have had real economic impacts, hurting new, large, and out-of-region suppliers, who are less likely to win the contracts. This type of favoritism risks undermining entrepreneurship and innovation, as it creates barriers for new entrants. In addition to the effect on suppliers, we also find suggestive evidence of a price increase in the subset of products with clear units of measurement and for which there is a substantial shift from auctions to direct contracts.

In order to shed light on the underlying mechanisms, we worked with the Comptroller to collect more information through additional audits. Results from these audits show that holding the amount and type of purchase constant, auctions undergo about 2.7 times as many checks as purchases through direct contracts, and lead to more than twice as many detected infractions. The effects are concentrated in the awarding stage of the procurement process, where the purchase procedure makes a big difference, rather than in the contract execution stage, where the process is similar, independently of the purchase procedure.

When procurement officers in public entities realize that they are more likely to be called out for infractions when using auctions, it can discourage them from using this purchase procedure even though the regulation aims to promote it. This pattern points to a more general issue: when audit protocols follow a simple checklist approach, which is standard in many settings, more heavily regulated processes with more steps, which leave a longer paper trail, may mechanically lead to more checks during an audit. If agents risk making a mistake in any given step of the process, procedures involving more steps will lead to a higher probability of being found to be incompliant. This can create unintended distortions.

Avoiding such distortions is a big challenge for anyone designing audit systems – both in the public or private sector – when audit protocols differ by procedure and when agents have some discretion over the choice of procedure. All else equal, institutions may want to equalize the expected cost of being audited across the different procedures. To set correct

incentives, they may, for example, consider adjusting audit probabilities or penalties, in order to counterbalance the fact that some processes involve more auditing checks. As discussed in the conceptual framework section, in the case of procurement this could mean equalizing the number of checks across different purchase procedures or increasing the penalties for infractions committed in direct contracts compared to auctions. In addition, auditors could focus in more depth on the key step involved in using a direct contract, i.e. the validity of the justification given for the use of this procedure. Finally, they can increase the overall audit probability for purchases awarded through direct contracting or for entities with higher use of direct contracts.[38]

Overall, these results suggest that it is key not to think of audits merely as "neutral" verification and information extraction mechanisms, but to carefully consider potential impacts and incentives created by the specifics of the audit design. This is in line with a growing number of findings showing that details of institutional design can have important impacts (Duflo, 2017). Given the widespread use and important functions of auditing, the audit design can have fundamental consequences for the functioning of the state and the private sector. While there is a large literature related to audit probabilities and detection risk, little economics research has focused on the incentives created by the audit design itself. Audit procedures are often developed by lawyers and administrative specialists. Getting economists involved in audit design promises high returns.

[38]This was, in fact, one of the policy changes the Chilean Comptroller implemented in response to the findings of this study.

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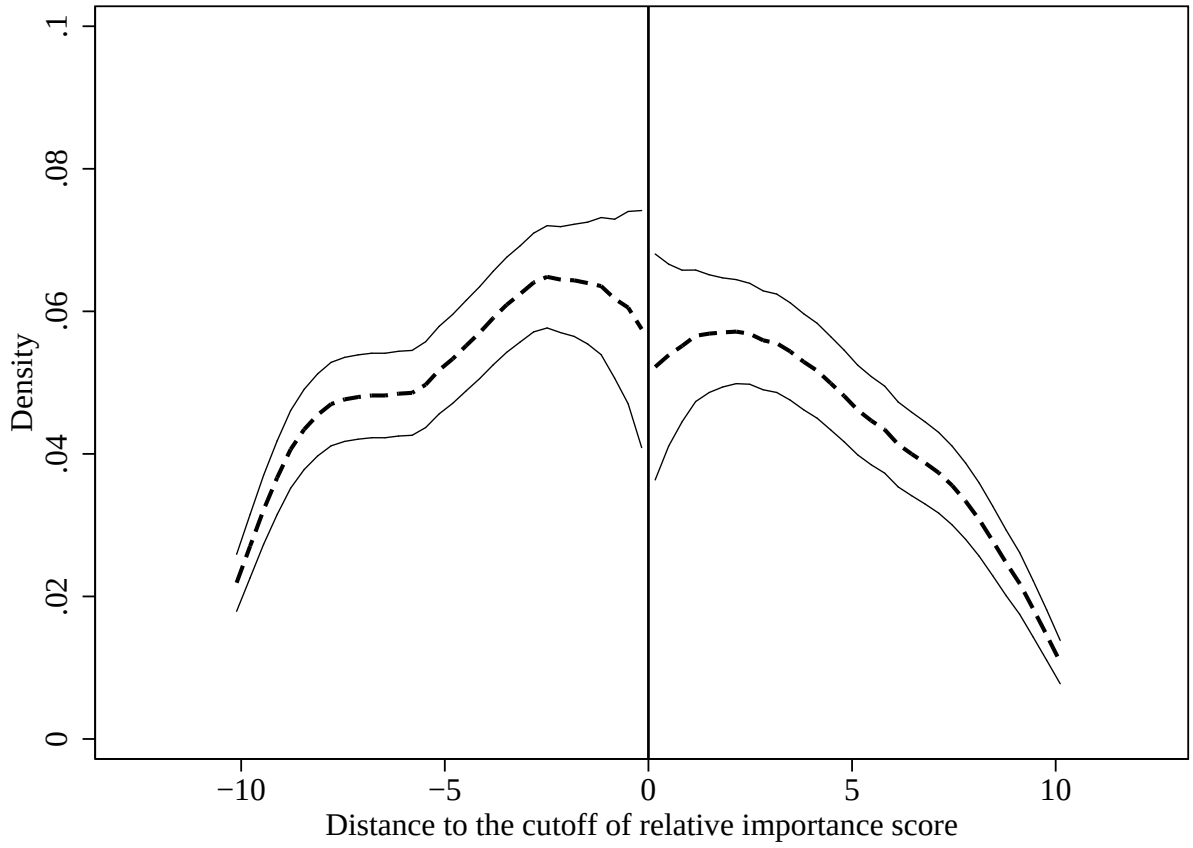
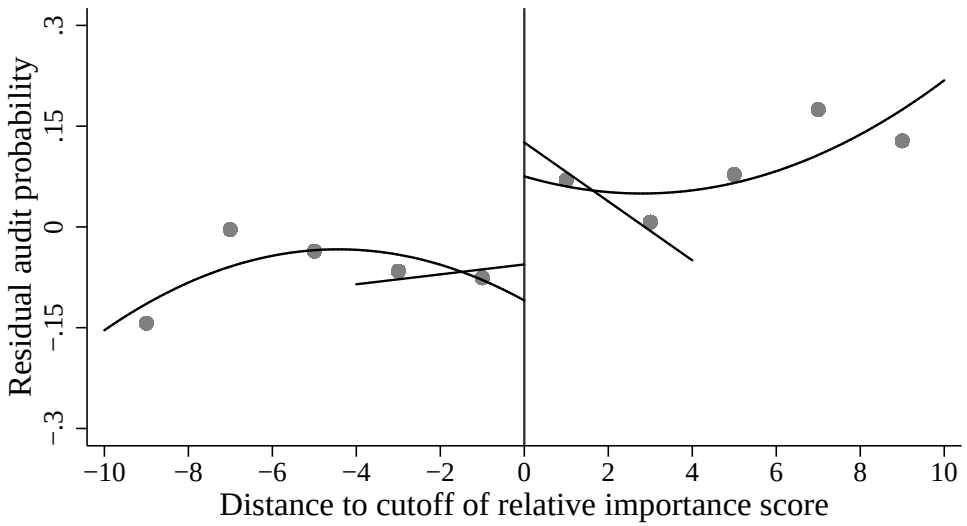
Figure 1:
McCrary Density Test



Notes: This figure shows the McCrary density test (McCrary, 2008) to analyze whether there is systematic bunching on one side of the cut-off. The dashed line indicates the density estimate, the solid lines show the 95% confidence interval. The estimated log difference in the heights at the cutoff is -0.1 and it has a standard error of 0.2. The analysis includes the pooled sample of entities in 2011-2012 with medium level of risk in the ± 10 range around the cutoffs of the importance score used in our main analysis. Zero indicates the cutoff at the stratum level. A stratum refers to a cell defined by year and internal unit.

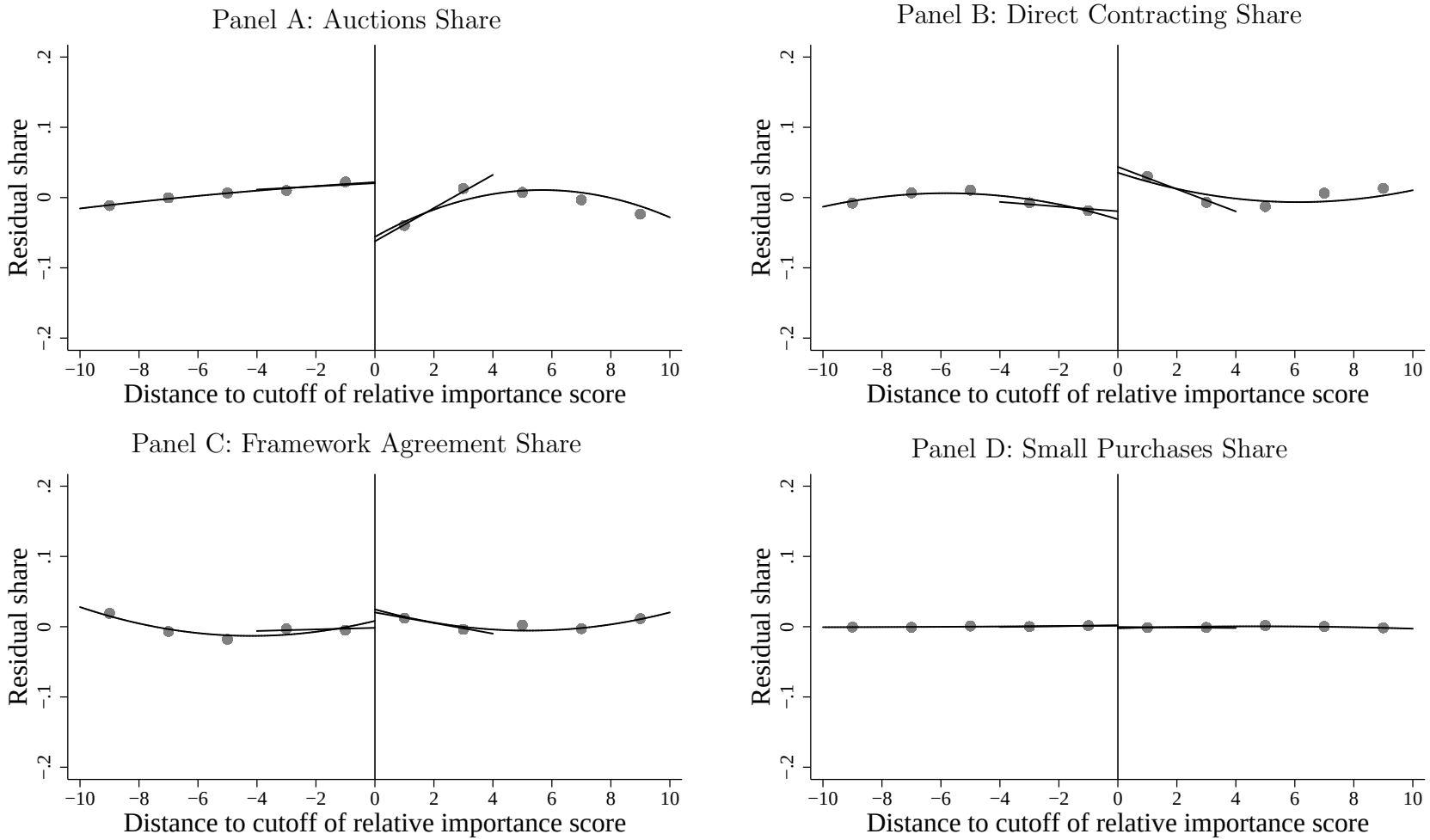
Figure 2:
Residual Share of Audited Entities (First Stage)



Notes: This figure shows the share of audited entities with medium level of risk in the ±10 range of the importance score for the years 2011 and 2012. The dots represent residual audit probabilities averaged within 2-point-wide intervals of the importance score. The residuals are obtained from a regression of the dummy for having been audited in a given year on stratum fixed effects and control variables. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased, and of auction and direct contract shares. Importance scores are normalized by stratum-level cutoff. A stratum refers to a cell defined by year and internal unit. Solid lines show linear and quadratic fits.

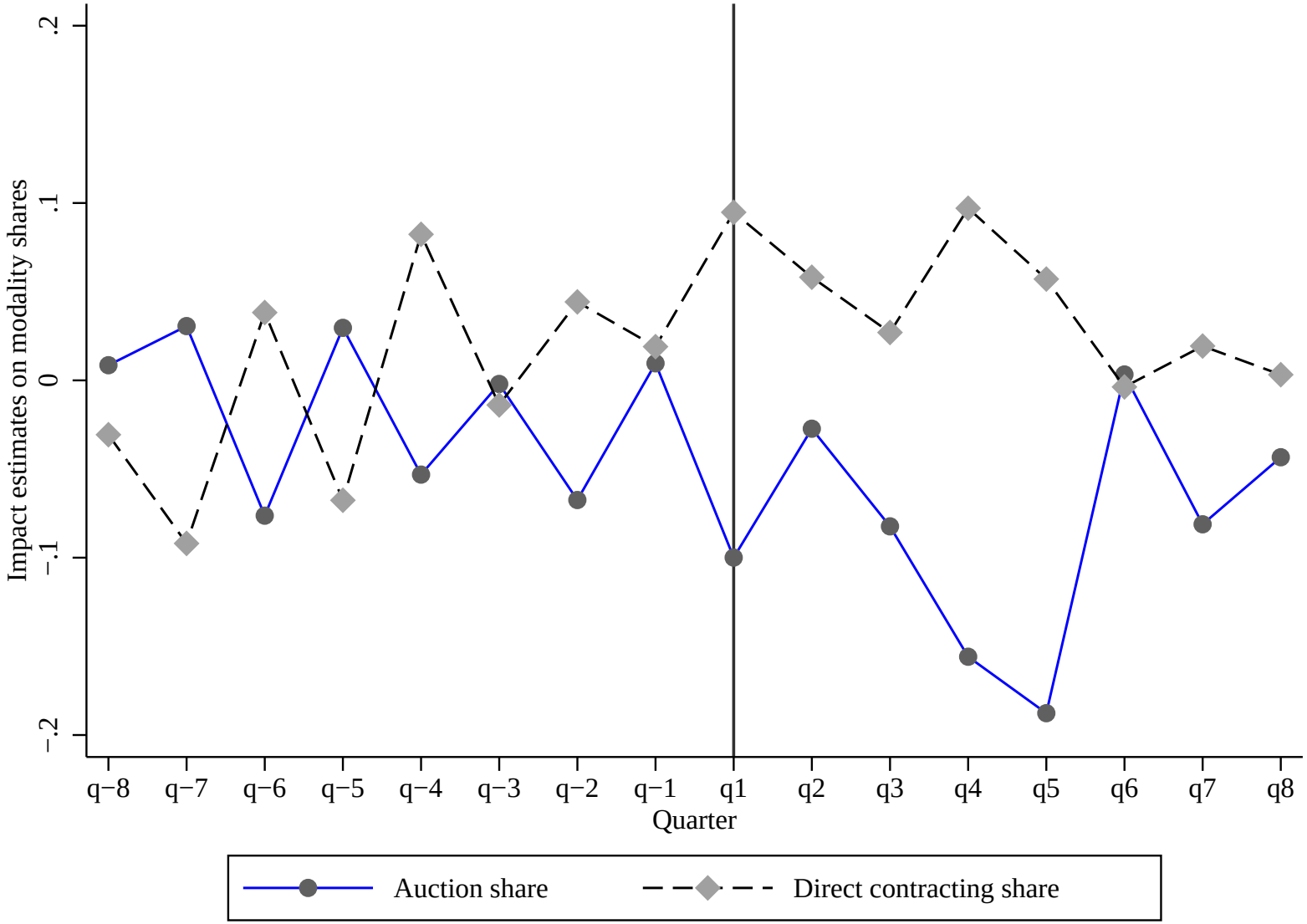
Figure 3:

Share of Purchase Amounts through Auctions, Direct Contracting, Framework Agreement and Small Purchases



Notes: This figure shows the amounts purchased through auctions (Panel A), direct contracting (Panel B), framework agreement (Panel C) and small purchases (Panel D), as a share of total purchases for entities with medium level of risk in the ±10 range of the importance score threshold for the years 2011 and 2012. The dots represent residual procedure shares averaged within 2-point-wide intervals of the importance score. The residuals are obtained from a regression of the outcome in a given year on stratum fixed effects and control variables. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased, of auction and direct contract shares, and of the outcome variable (where different). The importance score for each entity is normalized by the stratum-level cutoff. A stratum refers to a cell defined by year and internal unit. Solid lines show linear and quadratic fits.

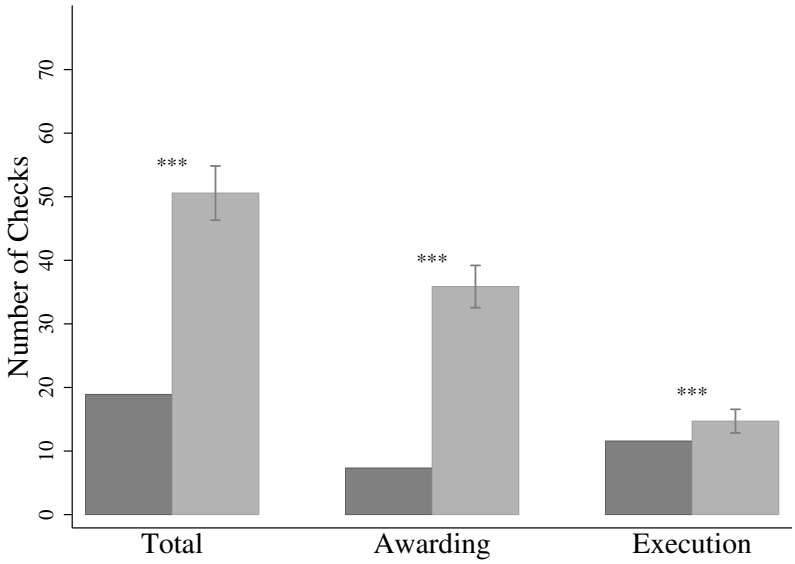
Figure 4: Impacts on Shares of Purchase Amounts through Auctions and Direct Contracting over Time



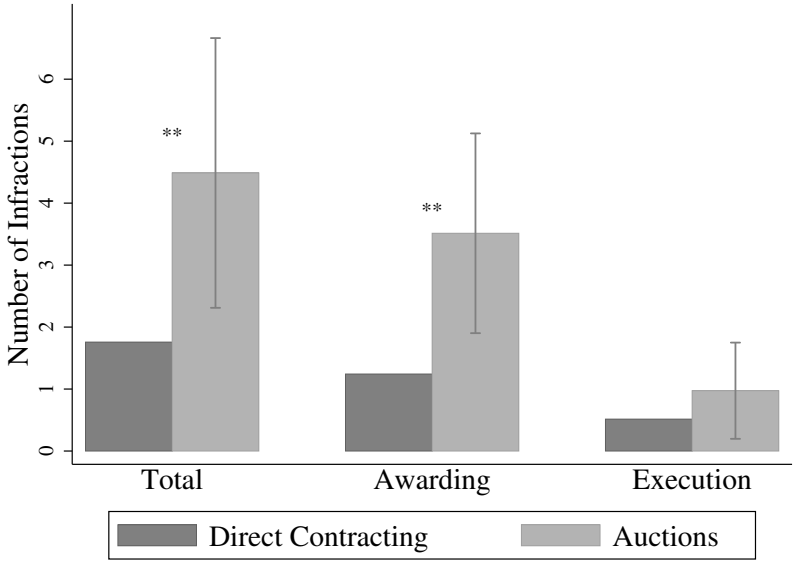
Notes: This figure shows the evolution of reduced form RDD estimates of impacts on auction and direct contracting shares over time, following Equation (2) on a quarterly basis. Coefficients plotted correspond to the bias-corrected estimates using the MSE-optimal bandwidth. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lag of log (+1) of total amount purchased, and of auction and direct contract shares. Period q corresponds to the first quarter of the treatment year.

Figure 5: Additional Audits: Checks and Infractions by Purchase Procedure

Panel A: Checks



Panel B: Detected Infractions



Notes: Panel A shows the number of checks per audited contract and Panel B shows the number of detected infractions. The left-hand set of bars displays the total number, the center bars show the number in the awarding stage, and the right-hand bars show the execution stage. The dark grey bars indicate mean numbers for direct contracts. The light grey bars show expected outcomes for auctions based on OLS regressions of the outcome on an auction dummy and controls for purchase amount, product, month of purchase, month of audit, and internal unit (as in Table A9 Panel B). The 95% confidence interval is based on the standard error of this adjusted difference estimate. Standard errors are clustered at the entity level. Appendix Figure A3 plots the same without controls.

Table 1:
Summary Statistics

Purchase Modality	(1) Amount in Millions of USD	(2) Share of Total Amount Purchased	(3) Number of Purchases	(4) Share of Purchases	(5) Average Number of Bidders/Quotes
			Panel A: Full Sample		
Auction	6,597	63.92%	4,350,037	50.81%	13.1
Direct contract	1,882	18.24%	1,285,021	15.01%	1.4
Framework agreement	1,803	17.47%	2,279,560	26.63%	
Small purchases	39	0.38%	646,932	7.56%	
			Panel B: Estimation Sample		
Auction	2,597	66.58%	1,827,455	52.76%	13.0
Direct contract	675	17.30%	482,816	13.94%	1.4
Framework agreement	613	15.72%	889,745	25.69%	
Small purchases	16	0.40%	263,575	7.61%	

Notes: The full sample consists of all $2,720$ procuring public entity-years in 2011 and 2012. The estimation sample consists of the $1,002$ public entity-years with medium risk whose normalized importance scores for the year in question was within the ± 10 range of the cutoff. Column (5) shows the average number of bidders in auctions and the average number of required quotes for direct contracting.

Table 2:
Balance Test

	(1)	(2)	(3)	(4)	(5)	(6)
	Comparison mean (±4)	Linear estimate (±4)	Linear estimate (±4)	Comparison mean (±10)	Quadratic estimate (±10)	Quadratic estimate (±10)
Direct contracting share, *t-1*	0.146	0.050	0.041	0.123	0.050	0.062
		(0.032)	(0.036)		(0.033)	(0.038)
Auctions share, *t-1*	0.656	-0.007	-0.026	0.695	-0.035	−0.069*
		(0.035)	(0.041)		(0.035)	(0.038)
Framework agreement share, *t-1*	0.183	-0.044	-0.018	0.168	-0.021	-0.000
		(0.029)	(0.030)		(0.030)	(0.028)
Log (+1) of total amount purchased, *t-1*	13.331	0.317	0.228	13.244	0.096	-0.089
		(0.322)	(0.357)		(0.311)	(0.319)
Direct contracting share, *t-2*	0.128	0.020	0.025	0.111	0.019	0.037
		(0.028)	(0.033)		(0.032)	(0.033)
Auctions share, *t-2*	0.694	0.009	-0.019	0.731	-0.005	-0.053
		(0.041)	(0.043)		(0.039)	(0.039)
Framework agreement share, *t-2*	0.155	-0.028	-0.007	0.138	-0.014	0.010
		(0.029)	(0.030)		(0.028)	(0.024)
Log (+1) of total amount purchased, *t-2*	13.176	0.233	0.198	13.079	-0.001	-0.072
		(0.349)	(0.423)		(0.339)	(0.387)
Audited, *t-1*	0.187	0.042	0.033	0.163	0.085	0.070
		(0.069)	(0.060)		(0.074)	(0.075)
Right-wing	0.671	-0.047	0.102*	0.695	-0.092	0.011
		(0.099)	(0.058)		(0.111)	(0.063)
Independent	0.108	0.069	0.010	0.103	0.071	0.040
		(0.052)	(0.040)		(0.057)	(0.042)
F-statistic		0.70	0.73		0.84	0.85
[p-value]		[0.744]	[0.710]		[0.596]	[0.590]

Notes: This table tests whether there is a systematic imbalance of covariates at the cutoff by running an RDD with the covariates as an outcome, as in Equation (2). Columns (1) and (4) show RDD comparison means in the ±4 and ±10 range. Columns (2) and (3) show linear estimates in the ±4 range, without and with stratum fixed effects, respectively. Columns (5) and (6) display the corresponding quadratic estimates. Each observation is an entity-year. The F-statistic is for a test of joint significance of all covariates. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table 3:
First Stage: Impact on Share of Audited Entities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Audit Probability							
1{Relative importance $\geq$ cutoff}	0.296***	0.203**	0.181**	0.299***	0.220**	0.193**	0.158**	0.183**
	(0.074)	(0.078)	(0.069)	(0.088)	(0.087)	(0.084)	(0.067)	(0.076)
Bandwidth	±4	±4	±4	±10	±10	±10	±6.51	±6.51
Observations	482	482	477	1,002	1,002	992	716	716
R-squared	0.035	0.311	0.396	0.050	0.276	0.354	0.402	0.402
Comparison mean	0.136	0.136	0.136	0.071	0.071	0.071	0.118	0.118
Spline	Linear	Linear	Linear	Quadr.	Quadr.	Quadr.	Linear	Linear
Stratum fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	No	No	Yes	Yes	Yes

Notes: First stage RDD estimates following the specification of Equation (1). Columns (1) to (3) show estimations for the ±4 bandwidth and Columns (4) to (6) for the ±10 bandwidth with varying number of control variables. Columns (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (8) in addition reports bias-corrected estimates and robust standard errors following Calonico et al. (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as log first and second lag of (+1) of total amount purchased, and of auction and direct contract shares. Standard errors are clustered at the level of the strata. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table 4:
Impact on Share of Purchase Amounts through Auctions and Direct Contracting

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Auctions				
1{Relative importance ≥ cutoff}	-0.065	−0.073*	−0.069**	−0.081**	−0.126***	−0.085***	−0.079***	−0.089**
	(0.045)	(0.043)	(0.032)	(0.038)	(0.036)	(0.027)	(0.030)	(0.036)
Bandwidth	±4	±4	±4	±10	±10	±10	±5.19	±5.19
Observations	482	482	477	1,002	1,002	992	604	604
R-squared	0.030	0.350	0.614	0.016	0.257	0.578	0.573	0.573
Comparison mean	0.637	0.637	0.637	0.665	0.665	0.665	0.666	0.666
				Panel B: Direct Contracting				
1{Relative importance ≥ cutoff}	0.087***	0.079**	0.061**	0.097***	0.109***	0.073***	0.069***	0.077***
	(0.032)	(0.037)	(0.028)	(0.032)	(0.038)	(0.025)	(0.024)	(0.028)
Bandwidth	±4	±4	±4	±10	±10	±10	±5.05	±5.05
Observations	482	482	477	1,002	1,002	992	593	593
R-squared	0.043	0.221	0.535	0.017	0.114	0.508	0.498	0.498
Comparison mean	0.136	0.136	0.136	0.110	0.110	0.110	0.125	0.125
Spline	Linear	Linear	Linear	Quadr.	Quadr.	Quadr.	Linear	Linear
Stratum fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	No	No	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Columns (1) to (3) show estimations for the ±4 bandwidth and Columns (4) to (6) for the ±10 bandwidth with varying number of control variables. Columns (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (8) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lag of log (+1) of total amount purchased, and of auction and direct contract shares. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table 5:
Impact on Share of Purchase Amounts Made through Auctions and Direct Contracting
by Number of Competitors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Auction with Bidders > 3				Panel B: Direct Contracting with 1 Quote			
1{Relative importance ≥ cutoff}	-0.051	-0.052	−0.073**	−0.084**	0.052*	0.061**	0.050**	0.058**
	(0.036)	(0.032)	(0.031)	(0.035)	(0.031)	(0.028)	(0.024)	(0.028)
R-squared	0.413	0.370	0.388	0.388	0.462	0.441	0.406	0.406
Comparison mean	0.319	0.326	0.322	0.322	0.106	0.089	0.097	0.097
Observations	475	989	548	548	475	989	601	601
Bandwidth	±4	±10	±4.65	±4.65	±4	±10	±5.15	±5.15
	Panel C: Auction with Bidders ≤ 3				Panel D: Direct Contracting with 3 Quotes			
1{Relative importance ≥ cutoff}	-0.044	-0.039	-0.028	-0.031	-0.005	-0.007	-0.002	-0.003
	(0.046)	(0.043)	(0.026)	(0.031)	(0.004)	(0.005)	(0.005)	(0.006)
R-squared	0.471	0.399	0.401	0.401	0.626	0.398	0.412	0.412
Comparison mean	0.340	0.354	0.381	0.381	0.020	0.016	0.016	0.016
Observations	475	989	960	960	475	989	587	587
Bandwidth	±4	±10	±9.47	±9.47	±4	±10	±5.00	±5.00
Spline	Linear	Quadr.	Linear	Linear	Linear	Quadr.	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Panels A to D show the impact on the share of purchase amounts made through auctions with > 3 bidders, direct contracts that require only 1 quote, auctions with ≤ 3 bidders and direct contracts that require 3 quotes, respectively. Columns (1) and (5) show estimations for the ±4 bandwidth and Columns (2) and (6) for the ±10 bandwidth Columns (3), (4), (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Columns (4) and (8) in addition report bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lag of log (+1) of total amount purchased, of auction and direct contract shares, and of the outcome variable. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table 6:
Probability that the Supplier is New, Large or from Out-of-Region

	(1)	(2)	(3)	(4)
		Panel A: New Supplier		
1{Relative importance ≥ cutoff}	−0.043**	−0.046***	−0.024*	-0.026
	(0.017)	(0.017)	(0.014)	(0.017)
Bandwidth	±4	±10	±5.45	±5.45
Observations	1,141,996	2,442,604	1,556,309	1,556,309
R-squared	0.210	0.179	0.195	0.195
Comparison mean	0.163	0.172	0.172	0.172
		Panel B: Large Supplier		
1{Relative importance ≥ cutoff}	−0.048**	−0.060***	−0.065***	−0.072***
	(0.019)	(0.017)	(0.021)	(0.023)
Bandwidth	±4	±10	±3.59	±3.59
Observations	1,141,996	2,442,604	1,017,045	1,017,045
R-squared	0.383	0.364	0.393	0.393
Comparison mean	0.308	0.299	0.303	0.303
		Panel C: Out of Region		
1{Relative importance ≥ cutoff}	−0.036*	−0.034*	−0.055**	−0.065**
	(0.020)	(0.017)	(0.027)	(0.031)
Bandwidth	±4	±10	±2.99	±2.99
Observations	974,540	2,093,256	703,570	703,570
R-squared	0.511	0.496	0.529	0.529
Comparison mean	0.431	0.445	0.467	0.467
Spline	Linear	Quadratic	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Each observation corresponds to a purchase. Results show impacts on the probability that the supplier has not sold to this entity in the preceding four years (Panel A), is a large firm (Panel B), or is from another region (Panel C). Panel C excludes procuring entities in the Metropolitan Region. Column (1) shows estimation for the ±4 bandwidth and Column (2) for the ±10 bandwidth. Columns (3) and (4) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (4) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, first and second lag of log (+1) of total amount purchased and of auction and direct contract shares, as well as month and product-unit fixed effects. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

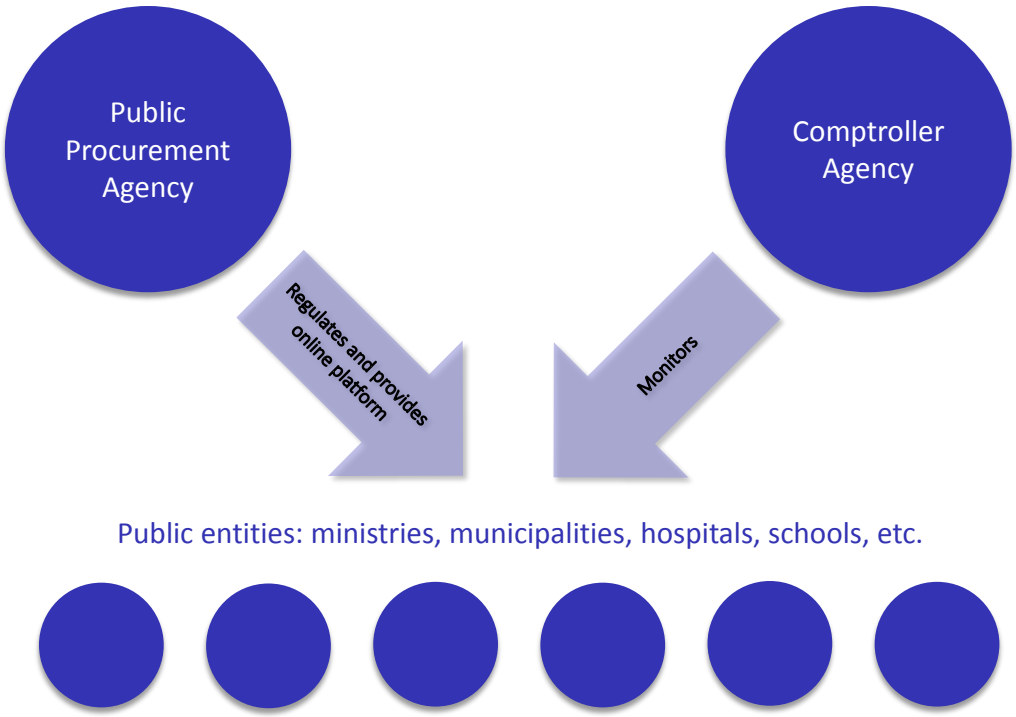
Table 7:
Impact on the Log of Unit Prices

	(1)	(2)	(3)	(4)
1{Relative importance $\geq$ cutoff}	0.113	0.148*	0.101**	0.137**
	(0.101)	(0.084)	(0.048)	(0.063)
Bandwidth	± 4	± 10	± 4.27	± 4.27
Observations	22,066	44,612	24,101	24,101
R-squared	0.800	0.813	0.809	0.809
Comparison mean	0.325	0.387	0.373	0.373
Spline	Linear	Quadratic	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Each observation corresponds to a purchase. Sample includes products with clear and comparable units and a sizeable shift in purchase procedure. Column (1) shows estimation for the ± 4 bandwidth and Column (2) for the ± 10 bandwidth. Columns (3) and (4) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (4) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, first and second lag of log (+1) of total amount purchased and of auction and direct contract, as well as month and product-unit fixed effects. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year, internal unit and type of entity. ***p<0.01, **p<0.05, *p<0.1

A Appendix Figures and Tables

Figure A1:
Institutions in the Chilean Public Procurement Process



Notes: This figure shows the public entities involved in the procurement process. The Public Procurement Agency "ChileCompra" regulates the procurement process and provides the online platform. The Comptroller Agency "Contraloría" implements audits and other monitoring functions of all public entities. Public procurement is implemented by entities from small schools or hospitals to entire ministries.

Figure A2:
Timeline

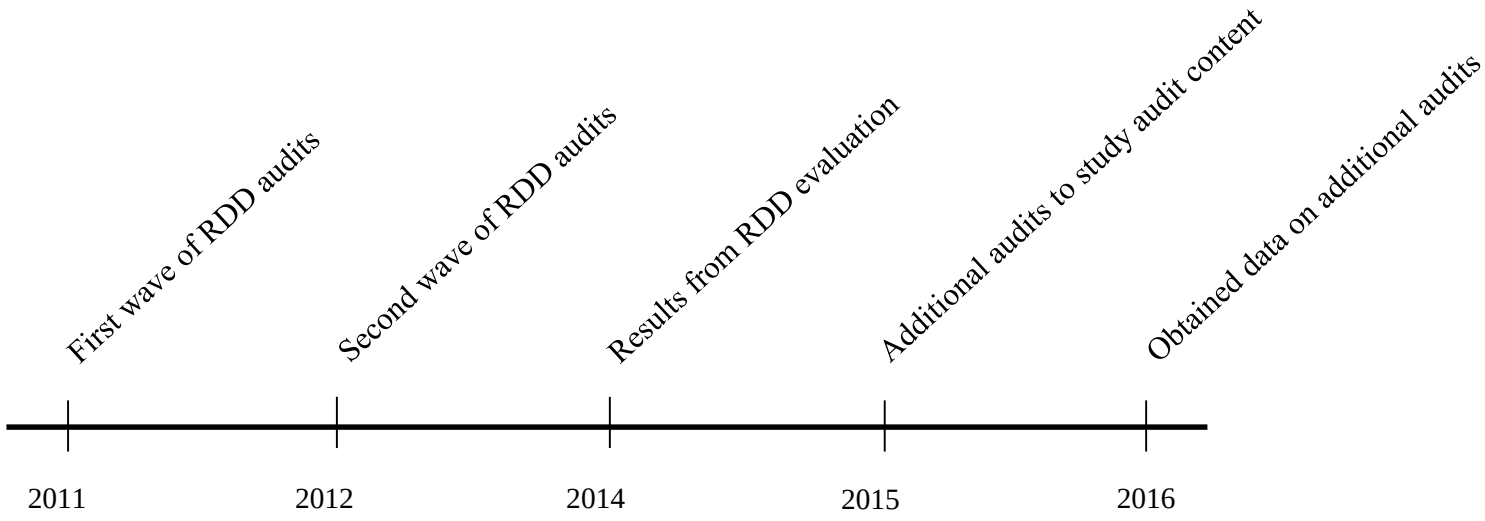
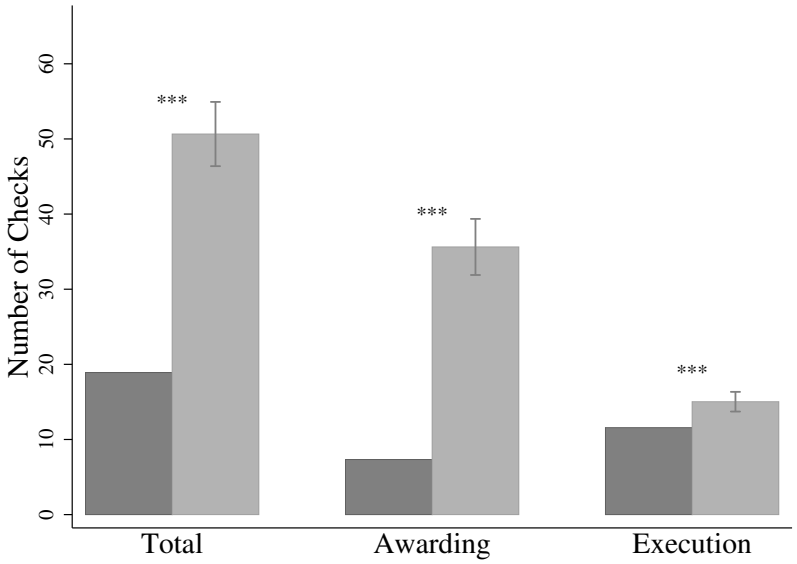
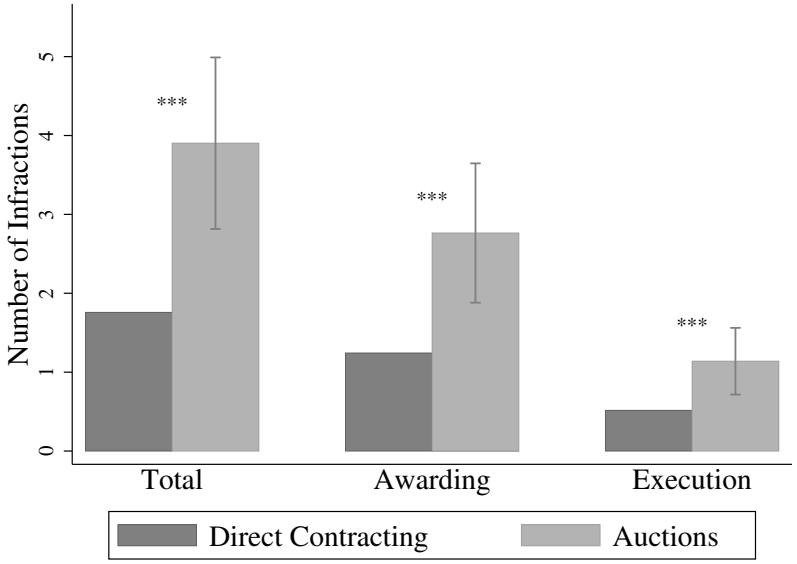


Figure A3: Additional Audits: Checks and Infractions by Purchase Procedure

Panel A: Checks



Panel B: Detected Infractions



Notes: Panel A shows the number of checks per audited contract and Panel B shows the number of detected infractions. The left-hand set of bars displays the total number, the center bars show the number in the awarding stage, and the right-hand bars show the execution stage. The dark grey bars indicate mean numbers for direct contracts. The light grey bars show expected outcomes for auctions based on OLS regressions of the outcome on an auction dummy (as in Table A9 Panel A). The 95% confidence interval is based on the standard error of this adjusted difference estimate. Standard errors are clustered at the entity level. Figure 5 plots the same with controls.

Table A1:
Impact on the Share of Audited Entities (First Stage), Pooling across All Four Potential Cutoffs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Audit Probability							
1{Relative importance $\geq$ cutoff}	0.159***	0.107*	0.103*	0.162**	0.114	0.119*	0.079*	0.087*
	(0.058)	(0.061)	(0.056)	(0.074)	(0.072)	(0.066)	(0.042)	(0.050)
Bandwidth	±4	±4	±4	±10	±10	±10	±7.29	±7.29
Observations	872	872	859	2,040	2,040	2,014	1,525	1,525
R-squared	0.014	0.169	0.292	0.030	0.170	0.289	0.288	0.288
Comparison mean	0.205	0.205	0.205	0.181	0.181	0.181	0.224	0.224
Spline	Linear	Linear	Linear	Quadr.	Quadr.	Quadr.	Linear	Linear
Stratum fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	No	No	Yes	Yes	Yes

Notes: RDD estimates following the specification of Equation (1). Columns (1) to (3) show estimations for the ±4 bandwidth and Columns (4) to (6) for the ±10 bandwidth with varying number of control variables. Columns (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (8) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased, and of auction and direct contract shares.. Standard errors are clustered at the level of the strata. A stratum refers to a cell defined by year, internal unit and type of entity. ***p<0.01, **p<0.05, *p<0.1

Table A2:
Impact on Log of Total Amount Purchased

	(1)	(2)	(3)	(4)
1{Relative importance $\geq$ cutoff}	-0.106	-0.033	-0.009	-0.002
	(0.134)	(0.109)	(0.062)	(0.076)
Bandwidth	± 4	± 10	± 10.45	± 10.45
Observations	477	992	1,019	1,019
R-squared	0.923	0.912	0.913	0.913
Comparison mean	13.667	13.522	13.856	13.856
Spline	Linear	Quadratic	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates of log (+1) of the annual amount purchased by the public entity following the specification of Equation (2). Column (1) shows estimations for the ± 4 bandwidth and Column (2) for the ± 10 bandwidth. Columns (3) and (4) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (4) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased, and of auction and direct contract shares. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year, internal unit and type of entity. ***p<0.01, **p<0.05, *p<0.1

Table A3:
Share of Purchase Amounts through Auctions and Direct Contracts
Interacting the Running Variable with Stratum Dummies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Auctions				
1{Relative importance ≥ cutoff}	-0.065	−0.092**	−0.089***	−0.081**	−0.110***	−0.083***	−0.086***	−0.095***
	(0.045)	(0.045)	(0.033)	(0.038)	(0.037)	(0.029)	(0.028)	(0.034)
Bandwidth	±4	±4	±4	±10	±10	±10	±5.16	±5.16
Observations	482	482	477	1,002	1,002	992	603	603
R-squared	0.030	0.456	0.675	0.016	0.329	0.628	0.630	0.630
Comparison mean	0.637	0.637	0.637	0.665	0.665	0.665	0.668	0.668
				Panel B: Direct Contracting				
1{Relative importance ≥ cutoff}	0.087***	0.081**	0.056**	0.097***	0.093**	0.062**	0.064***	0.072***
	(0.032)	(0.039)	(0.027)	(0.032)	(0.041)	(0.027)	(0.023)	(0.027)
Bandwidth	±4	±4	±4	±10	±10	±10	±5.30	±5.30
Observations	482	482	477	1,002	1,002	992	615	615
R-squared	0.043	0.367	0.604	0.017	0.183	0.576	0.575	0.575
Comparison mean	0.136	0.136	0.136	0.110	0.110	0.110	0.117	0.117
Spline	Linear	Linear	Linear	Quadr.	Quadr.	Quadr.	Linear	Linear
Stratum fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	No	No	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2) and additionally interacting each stratum dummy with the distance to the cutoff. Columns (1) to (3) show estimations for the ±4 bandwidth and Columns (4) to (6) for the ±10 bandwidth with varying number of control variables. Columns (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (8) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased and of auction and direct contract shares. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year, internal unit and type of entity. ***p<0.01, **p<0.05, *p<0.1

Table A4:
Impact on Share of Purchase Amounts through Auctions and Direct Contracting
Pooling Across All Four Potential Cutoffs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Auctions				
1{Relative importance ≥ cutoff}	-0.040	−0.072**	-0.041	-0.042	−0.082***	−0.037*	−0.038**	−0.041**
	(0.034)	(0.035)	(0.024)	(0.031)	(0.029)	(0.019)	(0.015)	(0.019)
Bandwidth	±4	±4	±4	±10	±10	±10	±8.32	±8.32
Observations	872	872	859	2,040	2,040	2,014	1,712	1,712
R-squared	0.011	0.305	0.628	0.008	0.241	0.591	0.597	0.597
Comparison mean	0.627	0.627	0.627	0.638	0.638	0.638	0.668	0.668
				Panel B: Direct Contracting				
1{Relative importance ≥ cutoff}	0.061**	0.057**	0.022	0.064***	0.068***	0.033*	0.032***	0.036**
	(0.025)	(0.028)	(0.021)	(0.023)	(0.025)	(0.017)	(0.012)	(0.015)
Bandwidth	±4	±4	±4	±10	±10	±10	±8.35	±8.35
Observations	872	872	859	2,040	2,040	2,014	1,715	1,715
R-squared	0.015	0.171	0.521	0.006	0.101	0.474	0.490	0.490
Comparison mean	0.142	0.142	0.142	0.131	0.131	0.131	0.129	0.129
Spline	Linear	Linear	Linear	Quadr.	Quadr.	Quadr.	Linear	Linear
Stratum fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	No	No	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Columns (1) to (3) show estimations for the ±4 bandwidth and Columns (4) to (6) for the ±10 bandwidth with varying number of control variables. Columns (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (8) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased and of auction and direct contract shares. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year, internal unit and type of entity. Interaction between stratum and distance to the cutoff is included. ***p<0.01, **p<0.05, *p<0.1

Table A5:
Impact on Share of Purchase Amounts through Direct Contracting by Justification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Unique Supplier				Emergency			
1{Relative importance ≥ cutoff}	0.012	0.012	0.015*	0.018**	0.042**	0.049***	0.044**	0.049**
	(0.009)	(0.008)	(0.008)	(0.009)	(0.018)	(0.017)	(0.018)	(0.021)
R-squared	0.491	0.404	0.430	0.430	0.307	0.210	0.276	0.276
Comparison mean	0.025	0.026	0.027	0.027	0.014	0.008	0.014	0.014
Observations	477	992	553	553	477	992	535	535
Bandwidth	±4	±10	±4.69	±4.69	±4	±10	±4.51	±4.51
	Trust in Suppliers				Disproportionate Cost			
1{Relative importance ≥ cutoff}	-0.004	0.001	0.004	0.004	-0.001	-0.002	-0.001	-0.001
	(0.006)	(0.006)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
R-squared	0.515	0.445	0.431	0.431	0.311	0.278	0.327	0.327
Comparison mean	0.014	0.012	0.012	0.012	0.003	0.004	0.003	0.003
Observations	477	992	967	967	477	992	843	843
Bandwidth	±4	±10	±9.50	±9.50	±4	±10	±7.95	±7.95
	Cost Less than 750 USD				Other			
1{Relative importance ≥ cutoff}	0.001	-0.004	-0.004	-0.005	0.008	0.021	0.015	0.017
	(0.005)	(0.004)	(0.004)	(0.005)	(0.017)	(0.018)	(0.016)	(0.019)
R-squared	0.649	0.544	0.648	0.648	0.682	0.563	0.621	0.621
Comparison mean	0.017	0.015	0.017	0.017	0.062	0.045	0.044	0.044
Observations	477	992	472	472	477	992	730	730
Bandwidth	±4	±10	±3.96	±3.96	±4	±10	±6.66	±6.66
Spline	Linear	Quadr.	Linear	Linear	Linear	Quadr.	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Columns (1) and (5) show estimations for the ±4 bandwidth and Columns (2) and (6) for the ±10 bandwidth. Columns (3), (4), (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Columns (4) and (8) in addition report bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased, of auction and direct contract shares, and of the outcome variable. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table A6:
Impact on Share of Purchase Amounts Made through Auctions and Direct Contracting by Size of Purchase

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Auctions							
	Below Mean Contract Amount				Above Mean Contract Amount			
1{Relative importance ≥ cutoff}	-0.001	-0.003	0.000	-0.004	−0.061*	−0.076***	−0.073***	−0.095**
	(0.005)	(0.004)	(0.004)	(0.004)	(0.033)	(0.027)	(0.028)	(0.045)
Comparison mean	0.071	0.079	0.077	0.077	0.566	0.586	0.589	0.589
Bandwidth	±4	±10	±5.19	±5.19	±4	±10	±5.19	±5.19
Observations	477	992	604	604	477	992	604	604
	Panel B: Direct Contracting							
	Below Mean Contract Amount				Above Mean Contract Amount			
1{Relative importance ≥ cutoff}	0.003	0.001	0.001	0.002	0.056**	0.071***	0.063***	0.073**
	(0.005)	(0.004)	(0.004)	(0.004)	(0.027)	(0.025)	(0.023)	(0.037)
Comparison mean	0.024	0.023	0.024	0.024	0.112	0.088	0.101	0.101
Bandwidth	±4	±10	±5.05	±5.05	±4	±10	±5.05	±5.05
Observations	477	992	593	593	477	992	593	593
Spline	Linear	Quadr.	Linear	Linear	Linear.	Quadr.	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Panel A shows small vs. large purchases made through auctions (contract amount below vs. above the mean amount of all purchases by entity). Panel B shows the same for direct contracting. Columns (1) and (5) show estimation for the ±4 bandwidth and Columns (2) and (6) for the ±10 bandwidth. Columns (3), (4), (7) and (8) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012) for all purchase sizes combined (as in Table 4) so that it is constant for a given procedure. Columns (4) and (8) in addition report bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased, of auction and direct contract shares, and of the outcome variable. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table A7:
Probability that the Supplier is from Out-of-Region, Including Entities in the Metropolitan Region

	(1)	(2)	(3)	(4)
1{Relative importance $\geq$ cutoff}	-0.026	-0.016	-0.022	-0.032
	(0.019)	(0.018)	(0.022)	(0.027)
Bandwidth	± 4	± 10	± 3.90	± 3.90
Observations	1,141,996	2,442,604	1,126,069	1,126,069
R-squared	0.468	0.447	0.469	0.469
Comparison mean	0.407	0.422	0.401	0.401
Spline	Linear	Quadratic	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Each observation corresponds to a purchase. Each observation corresponds to a purchase. Results show impacts on the probability that the supplier has not sold to this entity in the preceding four years (Panel A), is a large firm (Panel B), or is from another region (Panel C) (not excluding the Metropolitan Region). Column (1) shows estimation for the ± 4 bandwidth and Column (2) for the ± 10 bandwidth. Columns (3) and (4) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (4) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, first and second lags of log (+1) of total amount purchased, and of auction and direct contract shares, as well as month and product-unit fixed effects. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table A8:
Impact on the Log of Unit Prices

	(1)	(2)	(3)	(4)
1{Relative importance $\geq$ cutoff}	0.071	0.126*	0.062*	0.088*
	(0.084)	(0.074)	(0.037)	(0.049)
Bandwidth	± 4	± 10	± 4.93	± 4.93
Observations	27,671	54,899	35,381	35,381
R-squared	0.792	0.770	0.813	0.813
Comparison mean	0.374	0.401	0.504	0.504
Spline	Linear	Quadratic	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes

Notes: Reduced form RDD estimates following the specification of Equation (2). Each observation corresponds to a purchase. Sample includes products with clear and comparable units and a sizeable shift in purchase procedure. Column (1) shows estimations for the ± 4 bandwidth and Column (2) for the ± 10 bandwidth. Columns (3) and (4) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (4) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, first and second lags of log (+1) of total amount purchased, and of auction and direct contract shares, as well as month and product-unit fixed effects. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1

Table A9:
Additional Audits: Checks and Infractions by Purchase Procedure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Checks			Infractions			Investigation
	Total	Awarding	Execution	Total	Awarding	Execution	
	Panel A: Without Control Variables						
Auction	31.74***	28.29***	3.45***	2.15***	1.52***	0.62***	0.09*
	(2.18)	(1.90)	(0.67)	(0.55)	(0.45)	(0.22)	(0.05)
Constant	18.91***	7.33***	11.58***	1.76***	1.24***	0.52***	0.12
	(1.36)	(1.32)	(0.50)	(0.49)	(0.42)	(0.16)	(0.07)
Observations	105	105	105	105	105	105	105
R-squared	0.692	0.757	0.166	0.078	0.058	0.066	0.011
	Panel B: With Control Variables						
Auction	31.67***	28.54***	3.13***	2.73**	2.27**	0.46	0.12*
	(2.18)	(1.69)	(0.95)	(1.11)	(0.82)	(0.40)	(0.07)
Amount of purchase	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product code	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month of purchase	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control department	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Audit in September	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	104	104	104	104	104	104	104
R-squared	0.922	0.933	0.691	0.705	0.752	0.462	0.648

Notes: OLS estimations. Each observation is an audited purchase. The constant term captures the mean for direct contracts and the coefficient on "auction" measures the difference to direct contracts. Column (1) shows the total number of checks conducted. Columns (2) and (3) show the number of checks in the awarding and execution stages of the purchase, respectively. Column (4) shows the total number of infractions detected. Columns (5) and (6) show the number of infractions in the awarding and execution stages. Column (7) shows the probability of a follow-up action for serious infractions. Panel B has one less observation since control variables were missing for that purchase. Standard errors are clustered at the entity level. ***p<0.01, **p<0.05, *p<0.1

Table A10:
Impact on the Share of Audited Entities in the Subsequent Year

	(1)	(2)	(3)	(4)
	Probability of Audit in *t+1*			
1{Relative importance $\geq$ cutoff}	0.039	0.062	0.085	0.076
	(0.120)	(0.109)	(0.068)	(0.085)
Bandwidth	±4	±10	±8.86	±8.86
Observations	477	992	915	915
R-squared	0.381	0.275	0.288	0.288
Comparison mean	0.162	0.161	0.191	0.191
Spline	Linear	Quadratic	Linear	Linear
Stratum fixed effects	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes

Notes: RDD estimates following the specification of Equation (1). Column (1) shows estimation for the ±4 bandwidth and Column (4) for the ±10 bandwidth. Columns (3) and (4) employ the mean-squared-error-optimal bandwidth following Imbens and Kalyanaraman (2012). Column (4) in addition reports bias-corrected estimates and robust standard errors following Calonico, Cattaneo and Titiunik (2014). Each observation is an entity-year. Control variables include a dummy for having been audited in the preceding year (audits data are not available for two years earlier), political affiliation, as well as first and second lags of log (+1) of total amount purchased, and of auction and direct contract shares. Standard errors are clustered at the stratum level. A stratum refers to a cell defined by year and internal unit. ***p<0.01, **p<0.05, *p<0.1